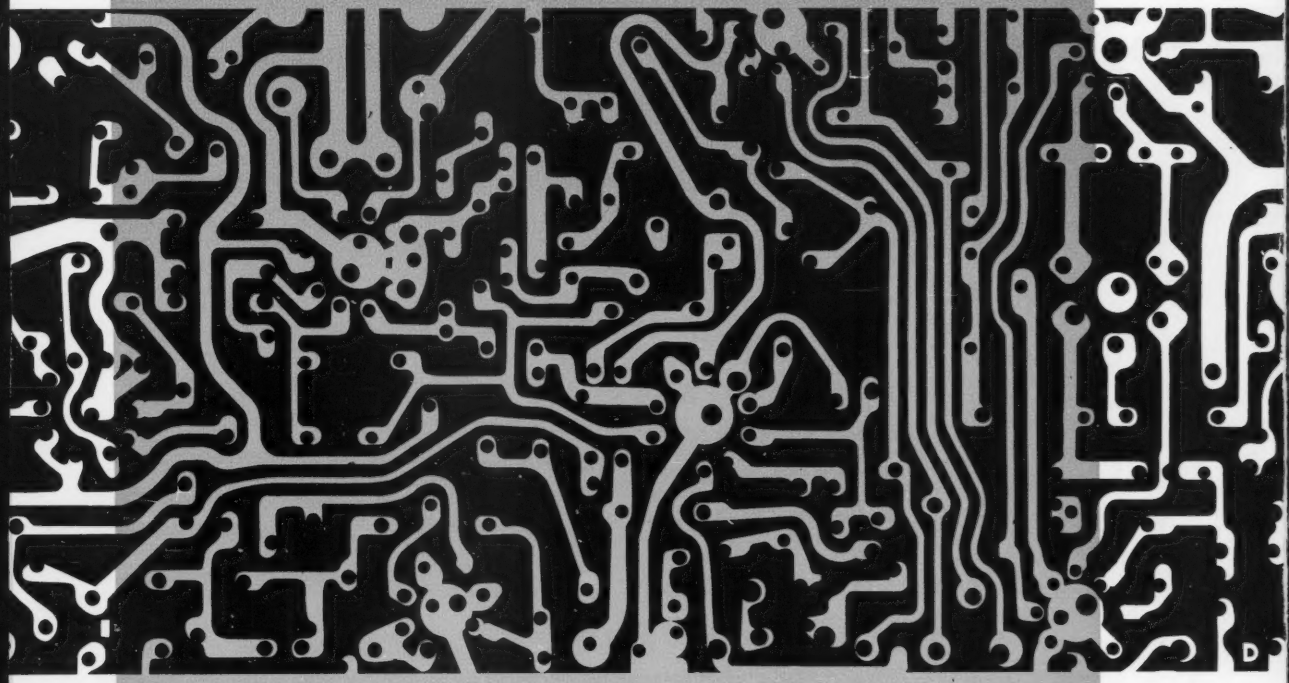
FEB 6 1957

Design Engineering

FIVE DOLLARS A YEAR



THE PRINTED CIRCUITS STORY **(page 38)**

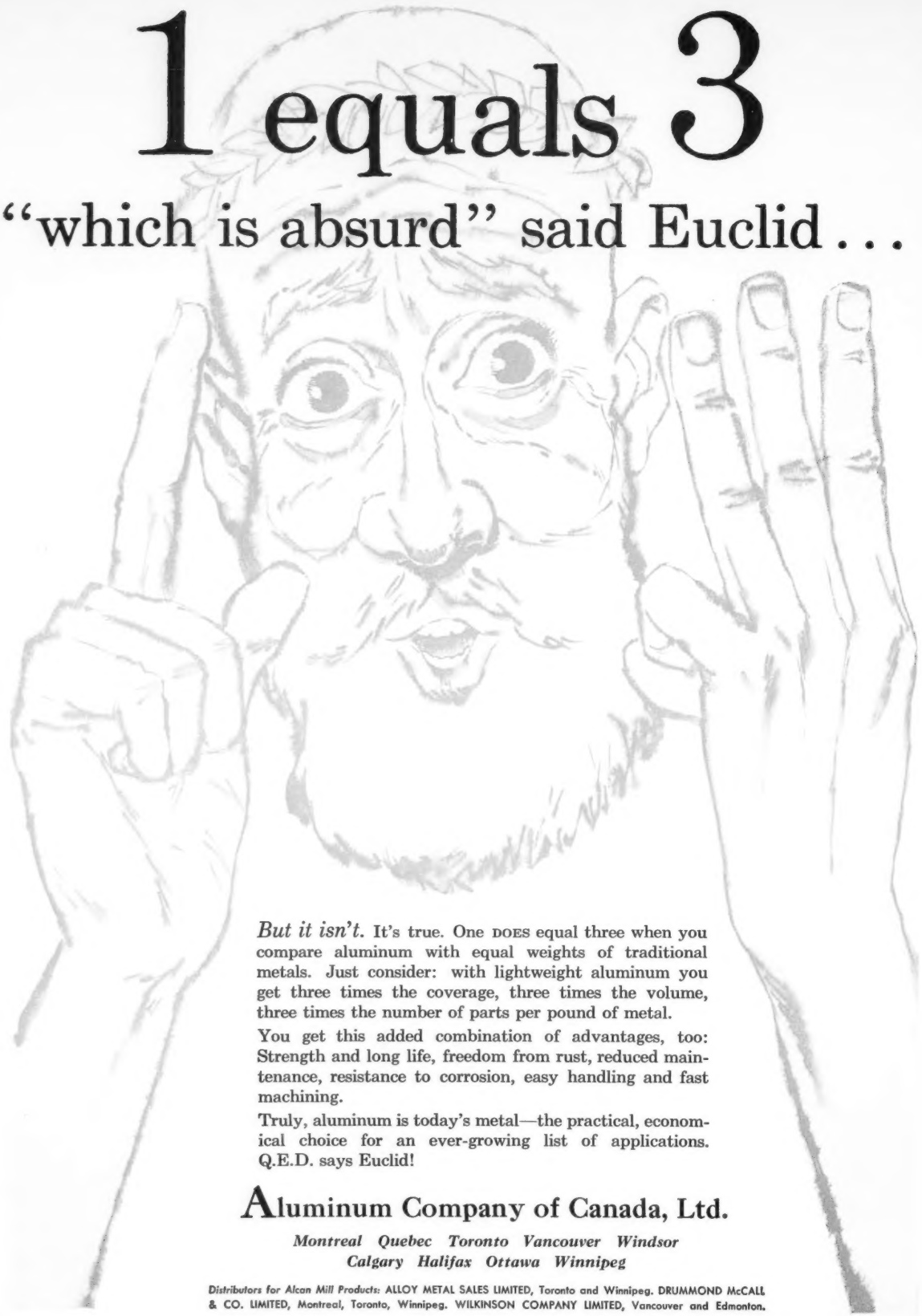
The new wiring method is simpler.
Use X-ray before machining parts.
Newest oil-pump is all-Canadian.

June 1955

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA

1 equals 3

"which is absurd" said Euclid . . .



But it isn't. It's true. One DOES equal three when you compare aluminum with equal weights of traditional metals. Just consider: with lightweight aluminum you get three times the coverage, three times the volume, three times the number of parts per pound of metal.

You get this added combination of advantages, too: Strength and long life, freedom from rust, reduced maintenance, resistance to corrosion, easy handling and fast machining.

Truly, aluminum is today's metal—the practical, economical choice for an ever-growing list of applications. Q.E.D. says Euclid!

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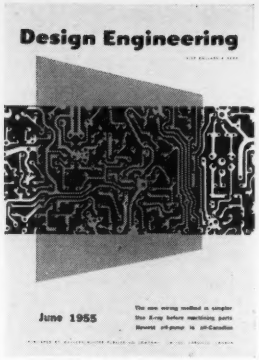

Design Engineering

VOLUME 1 **JUNE, 1955** NUMBER 3

This month's cover

This month's cover looks simple. It was not simple to create! How do you symbolize a story which is more a process than a product? Many heads were scratched and many roughs studied before artist Don Dancer came up with a simple sketch of printed circuit routes stripped across the page on a Phenolite-colored wedge background. The design is less abstract than previous covers but the editors like it. Do you? Look for the story on page 38.

Design Engineering

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Editorial correspondents in: The United Kingdom, the United States, Germany, France and Italy.

The July issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

Photography in Industry will be the lead feature. The camera has become an important industrial tool and this article will bring you up to date on what it will do.

Magnetic Amplifiers are important to you. They too will be discussed with all the latest information included.

Off Highway Transporter is a dramatic new Canadian design. Look for it too.

Special Artwork

Editorial layouts designed by art consultant **Desmond English.**

BOGART

THE FEATURE ARTICLE in this month's Design Engineering deals with printed circuits (page 38). **Robert Frazer Bogart** who wrote it is a well qualified authority; he is application engineer for the National Fibre Co., of Canada, spends much of his time acting as consultant to customers; he knows the questions that are asked and hopes he has answered them in advance in his article. He holds a B.Sc. degree in chemistry.

GREEN

NINETEEN YEARS AGO, westerner **James Green** started designing an oil well pump which worked on a wholly new principle. The labor is now coming to an end, the pump is almost a reality and its designer looks likely to find his long effort rewarded with success. There has been variety in the life of James Green. For 10 years he taught in Peace River schools. Then for two years he studied at Alberta's university but found he could not afford to complete. He went to the Turner Valley oil fields, later (during the depression years) prospected for gold. After years of labor the first model pump was built; but a fire burned his machine shop and pump—and he had to start again. Now, for the second time the pump is ready. It is described in this issue (page 34).

NEAPOLE

WHILE HE WAS still at school, **G. E. Neapole** set up a home made X-ray unit and made many exposures. Because it was powered by dry cells, he found his exposures rather long and money rather short. The cost of batteries brought the experiment to a sorrowful end but not before many "small dead animals" had been very fully X-rayed. He writes now about X-ray on a much bigger scale (page 27) and draws on his 10 years of experience with Ferranti Electric Ltd.,

CAWLEY

THE AUTHOR of the article on Mylar (page 30) is much more than a film authority. **J. C. "Tim" Cawley** is also a one-time fighter pilot and a keen figure skater. He joined the Films Division, Du Pont Co. of Canada in 1948 in Toronto, was later moved to Montreal and quickly promoted.

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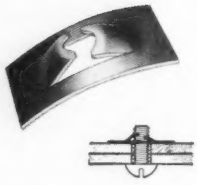
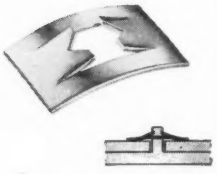
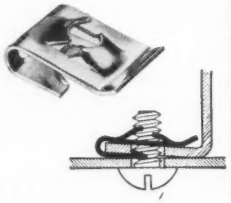


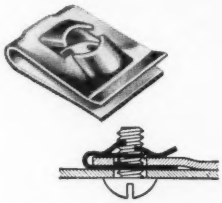
FLAT TYPE — One-piece self-locking spring steel fasteners. Replace threaded nuts, lock washers or spanner washers. Available in a wide variety of shapes and screw sizes.



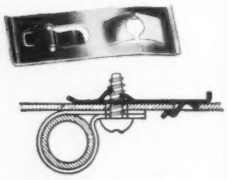
PUSH-ON — Zip over unthreaded die cast or plastic studs, rivets, nails, tubing, or wire to lock parts securely. Removable types available in many sizes.



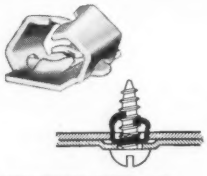
"J" TYPE — Snap over edge of panels and into center hole locations. Hold themselves in place for blind assembly. Full range of panel thicknesses and screw sizes available.



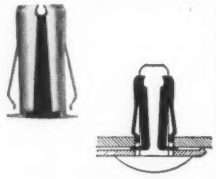
"U" TYPE — Perform same function as "J" type for reduced materials handling. Used where full bearing on lower leg of the Speed Nut is required.



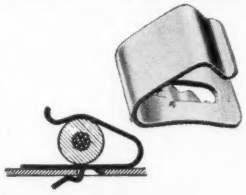
LATCH TYPE — Easily applied by hand, are self-retained in bolt-receiving position at center panel locations for blind attachments. Front mounting types are also available.



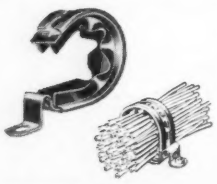
EXPANSION TYPE — For lightning-fast attachments in blind locations. Snap into mounting holes by hand Screw spreads spring fingers, wedge-locks part in position. Secure, vibration-proof attachment.



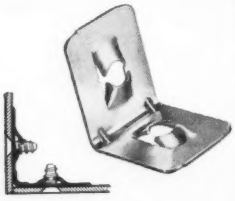
TUBULAR CLIPS — For use with unthreaded studs or rivets. Virtually "nails" panels together where there is access to one side only. Permanent lock or removable types.



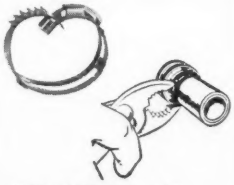
CABLE, WIRE, AND TUBE RETAINERS — Snap in place by hand, self-retained in position to receive wide range of cable, wire and tube sizes. Easily removed for service or re-location.



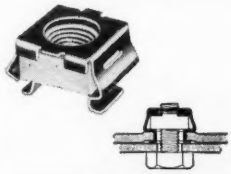
HARNESS CLAMPS — Open or close by hand — no tools needed. Attach to panel or pre-assembly to harness before installation. Cushioned to protect wires. Cannot open accidentally.



ANGLE BRACKETS — Combine bracket and fastener to reduce number of parts, speed up assembly and strengthen the structure. Variety of shapes and sizes.



HOSE CLAMPS — Self-locking, ratchet-type design, one-piece low profile construction — no bolts, nuts or thumb screws. Fast and easy to apply and remove for medium- and low-pressure connections.



NUT RETAINERS — Retain square nuts in blind locations. No welding, clinching, staking — snap in by hand. Provided in a wide range of screw sizes. "U" and "J" type retainers available.

A fastener is an important part of any product. Careful study and analysis of its design and function can greatly improve product quality and lower the over-all production costs. The Speed Nut method of fastening has provided an economical and efficient solution to countless attachment problems. There are more than 6,000 types and sizes of Speed Nut fasteners available for your needs. If necessary a new fastener can be engineered to suit your requirements. Write today for the full Speed Nut story.

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Reports

News in brief from the world's producers

WITH THE EXCEPTION of heavy bombers, Germany will be allowed to build aircraft again as soon as the Paris defense agreements have been ratified by all countries. Is she equipped to do so? H. Focke, world-famous German aviation pioneer, thinks not.

"Aerotechnics are going ahead so fast," he said when questioned about it, "that an engineer who did everything except build his own aircraft for years, has lost touch." Focke, who among many other things designed one of the world's first helicopters is now teaching at a German university.

The other top German names in aviation have slipped out of the business too. Messerschmitt, Heinkel and Dornier are all still living but, have been without suitable plants and staffs since 1945 when the German aviation industry was dismantled.

Ernst Heinkel still heads a manufacturing plant but makes motor scooters instead of aircraft and employs 500 men instead of the 52,000 of a few years ago.

Any revival of the German aircraft industry will have to start from the beginning. First, say the experts, light sporting aircraft will be built. Later, if conditions are right, heavier planes will be manufactured under license.

Professor Heinkel gave DESIGN ENGINEERING a gloomy forecast. "An independent airplane industry will be impossible for us. German engineers will just have to work closely with their colleagues in the Western hemisphere."

• • •

ONCE AGAIN the National Industrial Design Council is helping to send young Canadian designers to the annual two-week summer course at the famed Massachusettes Institute of Technology.

Last year NIDC met the full costs. This year it decided to try the experiment of halving the cost with companies employing the chosen designers. D. W. Buchanan, the Council's secretary, describes the response as "most encouraging." Seven companies willingly took on their share of the expense ($125).

The scholarship holders are: D. C. McCormick (J. A. Wilson Lighting and Display Co. Ltd.); Jan Kuypers; Earle A. Morrison (Consultant designer); J. F. Rowan (consultant designer); Thomas G. McCusker (Ensor Industrial Design Associates); Jean Claude Hetu and Victor E. Roth.

What do Canadian designers get for their (total) $250? A series of lectures and discussions aimed at what the MIT describes as a "quite pragmatic" approach to "creative processes."

To MIT, new designs must be better ones than have gone before—not just "different." The course starts on the 20th of this month and ends on July 1.

• • •

A NEW EXECUTIVE has been elected to head the National Industrial Design Council. It consists of three members: Jean M. Raymond, chairman (Raymond Manufacturing Co.); Floyd S. Chalmers, vice-chairman (president, Maclean-Hunter Publishing Co.); and J. S. Corrigan, vice-chairman (assistant to the president, General Steel Wares Ltd.).

Twenty members were also elected who meet twice yearly to vote on policies followed by the executive.

• • •

WORK WILL SOON START on a new 66,000 tons-a-year ammonia plant for **Canadian Industries (1954) Ltd.**, located near Kingston, Ont. It will cost about $7 million.

• • •

A CHANGE of address is announced by **Paul Dilworth and Co.**, who have moved to new offices at 4210 Dundas Street West, Toronto. The company provides engineering and development services.

• • •

A TRANS-ATLANTIC air cargo service, the first of its kind, has just been started by **Airwork Atlantic (Canada) Ltd.**

On the recent maiden flight from Manchester, Eng., to Montreal, via New York, the cargo consisted of a David Brown tractor, the first one on this continent to be fitted with the TCU device (see elsewhere in this issue).

The aircraft used will be DC-6A Liftmaster and C-54 Skymaster. These can carry over 12 tons of cargo over the Atlantic. Scheduled are two flights a week.

• • •

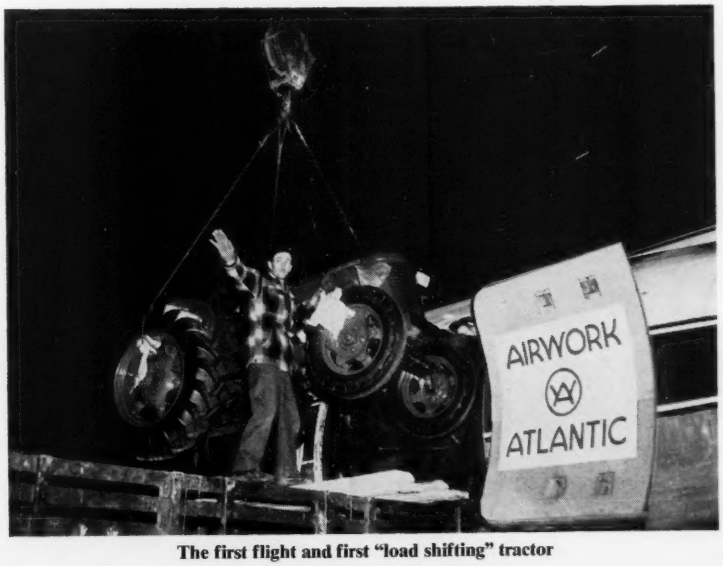
RECENT DISCLOSURES about the $857 million plan to achieve an abundance of electric power for industry and the home by straddling the country with a network of twelve nuclear power stations, have given Englishmen a sense of sharing in the new Industrial Revolution.

The 12 nuclear power stations will provide a total capacity of 1,500,000 to 2,000,000 kw by 1956, and one sixth of the country's electric power by 1970. It is also expected that there will be a big demand from abroad for the provision of similar plants and techniques.

Britain, in thus freeing herself from the tyranny of diminishing coal reserves, seems likely to repeat in this century her nineteenth century Industrial Revolution.

An experimental atomic power station at Calder Hall, Cumberland, is expected to be completed by March, 1956, at a cost of between $42,000,000 and $57,000,000. Its output will be fed into the national electricity grid.

Big engineering concerns in the U. K. have been quick to take up the challenge of the new era. Plans for participation in the development of nuclear power stations have been announced by Associated Electrical Industries, English Electric and General Electric Company.



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For frequent stepless speed changes, Motion Control *Vari-Pitch* sheaves permit speed adjustments while the unit is in operation. These sheaves are available for standard belts and permit up to 25% speed variation.

Contact the CA-C Sales Office nearest you for complete information on how *Vari-Pitch* sheaves can help you to maintain correct operating speeds, or write today to Canadian Allis-Chalmers Ltd., P.O. Box 37, Montreal, Que., for bulletin 20B7499B.

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CA-1

Announcing–the new LPD design **Clipper Oil Seal**

The design of the new LPD Clipper Seal assures that the spring which controls the lip contact on the shaft will be held tightly in the seal. It further provides a husky lip section that enables better control of lip flexing, and better utilization of the full available depth of the lip section.

. . . an efficient, all-purpose seal with long life and a wide range of applications

EXHAUSTIVE FIELD TESTS and customer usage show that the new Type LPD Clipper Seal has a wider range of applications than any other oil seal design.

It provides better retention of lubricant and more thorough exclusion of dirt and abrasives. This holds true even at higher shaft speeds and despite wide equipment variables. It can be used for practically any application with greater assurance of fewer replacements.

The new Type LPD Clipper Seal runs cool and lasts longer because it requires less lubrication over its lip bearing area. Furthermore, the LPD design provides better utilization of the lip section of the seal—another factor in prolonging its life. And the greater flexibility of this lip section improves the performance of the seal.

The heel and lip compounds in which the new Type LPD Clipper Seal is available enable it to withstand a wide range of service conditions and temperatures. For more information about the new Type LPD Clipper Seal, write Canadian Johns-Manville, 565 Lakeshore Road East, Port Credit, Ontario.

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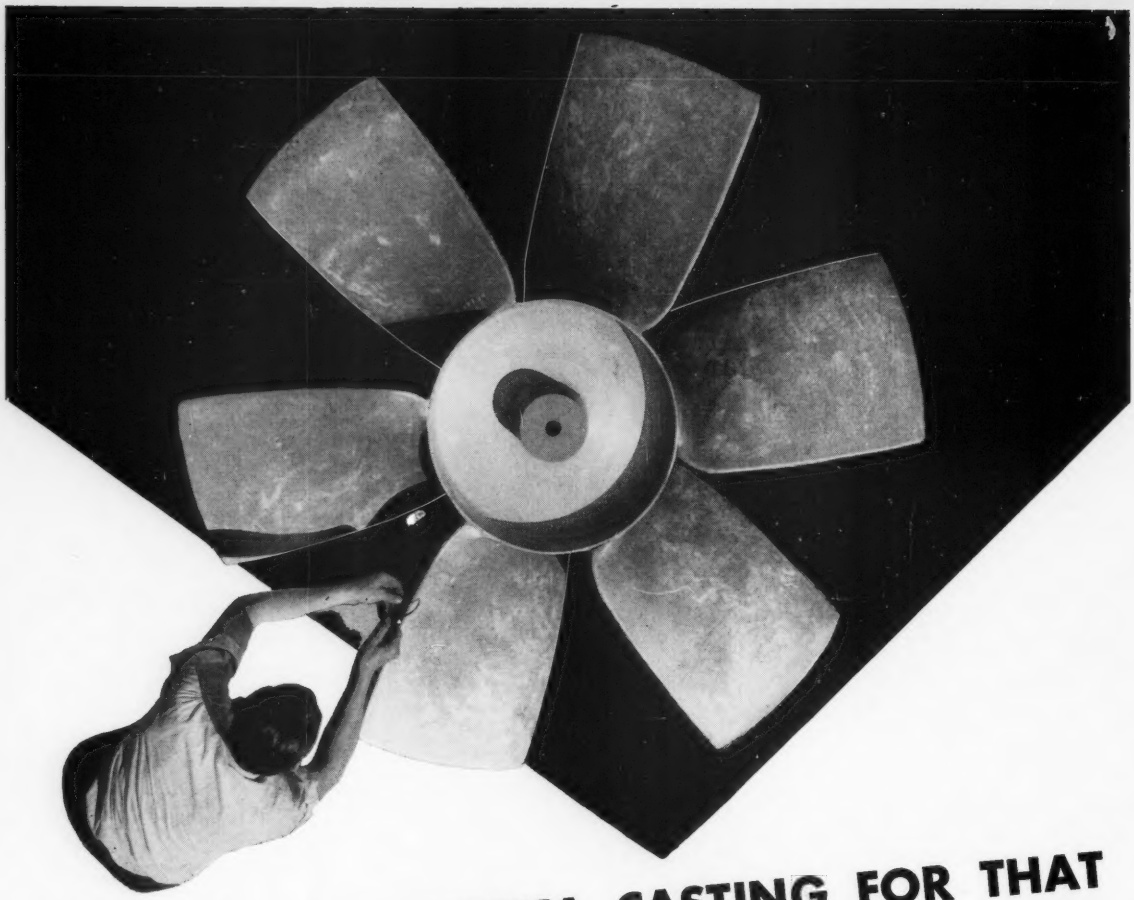

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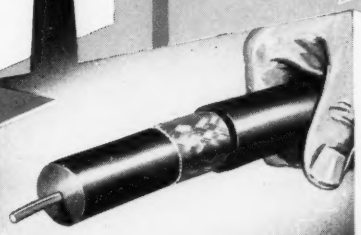

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a new foamed-in-place expansible resin

Here is a low density product with a multiplicity of applications. It is easily prepared by mixing a catalyst at ordinary room temperatures. The slightly viscous mixture can be poured or sprayed into cavities of almost any size and shape desired. During foaming, the resin expands to fill the shape of the container and after curing will bond strongly to its sides.

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ISOFOAM is recommended for use in a wide variety of applications. Batch mixing as well as continuous mixing and spraying devices open new methods of production techniques resulting in considerable savings in labour costs.

Because of its poor heat transfer, ISOFOAM is recommended for insulating home freezers, refrigerators, water coolers refrigerated trucks and railroad cars and other refrigerated units. Good for covering low temperature lines, low pressure steam lines and valve clusters located in relatively inaccessible places.

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Can be used as a core material for randomes in aircraft and guided missiles.

Can be used in most types of buoyancy and flotation gear. With articles subject to constant immersion in water, an additional thin coat of paint or cover of plastic would provide extra protection.

ADVANTAGES

- **Easy Handling**
  Easily mixed, convenient to apply. Mixed prior to use at point of application, and readily poured where required. Labour costs are drastically reduced.
- **Foamed in Place**
  Spontaneously expands after pouring or spraying to fill a cavity or cover a surface.
- **Self-Curing**
  No external heat is necessary to cure expanded material.
- **Good Adhesion**
  Shows good adhesion to surfaces such as metals, glass, Fiberglas laminates, wood, fabrics and most plastics.
- **High Moisture Resistance**
  Fine cellular structure prevents absorption of moisture or liquids to any appreciable extent.
- **Good Thermal Insulation**
  Due to the gas trapped in the many small cells comprising its structure. Values are comparable with some of the best known insulating products.
- **Resistance to Oil, Vibration**
  Resistant to oils, greases and most petroleum products. Resists vibration and will not settle or sag. Is non-friable and will not shake loose even under hard use.

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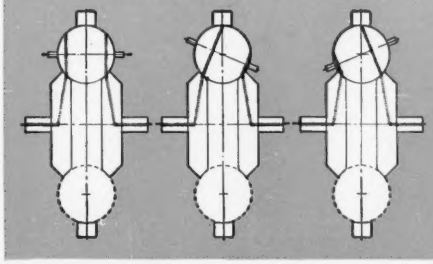
For detailed description and specifications, write for Bulletin K-100, Peacock Brothers Limited, P.O. Box 1040, Montreal, Que.

HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (see diagrams, left, and cutaway view, right).

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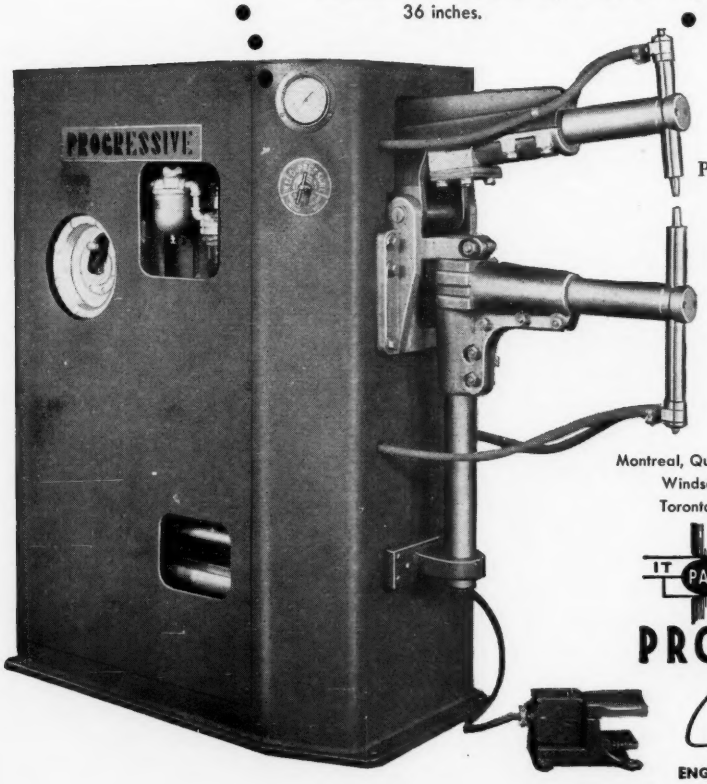

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G-E CARBOLOY THERMISTORS are circuit elements with a highly sensitive response to minute changes in temperature. They have a negative coefficient of resistance — *resistance decreases with increased temperature* — and, their temperature coefficient is much larger than that of any other known material. These features, coupled with excellent stability and aging resistance, offer industry and science the opportunity to detect, measure and control energy to a degree never before economically possible.

Carboloy Thermistor applications can be divided into two broad classifications, depending upon the operating characteristics of the element used and the functions performed. These are determined by whether: (1) the element is controlled by ambient temperature; or (2) the element is heated by the current in the circuit with which it is associated. The first includes applications involving temperature measurement and control, and temperature compensation. The second, covers uses involving voltage-current and current-time characteristics; such as time delay devices for relay operations, timing devices, sequence switching, safety and warning circuits, voltage regulators, flow meters and vacuum gauges.

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1. **A large negative temperature coefficient of resistance.**
2. **Response to minute temperature changes.**
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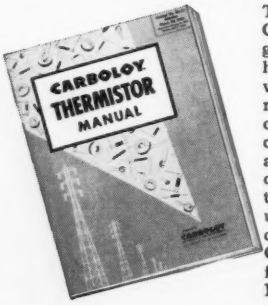
5. **Can eliminate mechanical timers.**
6. **Can eliminate current surge in electrical circuits.**
7. **May be used with electrical conductors to compensate for changes in their resistance due to temperature changes.**
8. **Will reduce cost, size and weight of products and processes.**
9. **They last indefinitely — need no maintenance.**

CARBOLOY THERMISTORS

Free Technical Manual Gives Application Data and "Ideas"



This free technical book, Carboloy Thermistor Manual, gives extensive information helpful to persons concerned with the design or improvement of products and processes. It includes basic circuits and performance curves, and "idea" circuits, with curves, are provided as a guide to the best utilization of the unusual operating and physical characteristics of G-E Carboloy Thermistors. Write for this 56-page manual today. Mail the coupon below.

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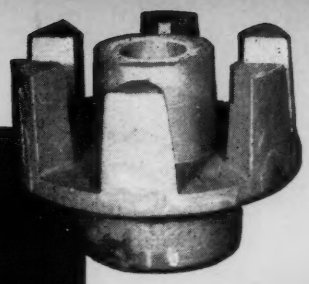

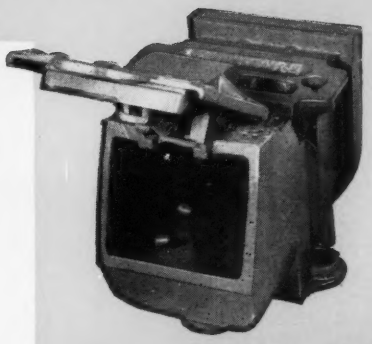

DUCTILE IRON provides mechanical properties approaching those of cast steel. In addition, it combines the machinability and wear-resistance as well as the fluidity and castability of cast iron.

CHARACTERISTICS OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness.
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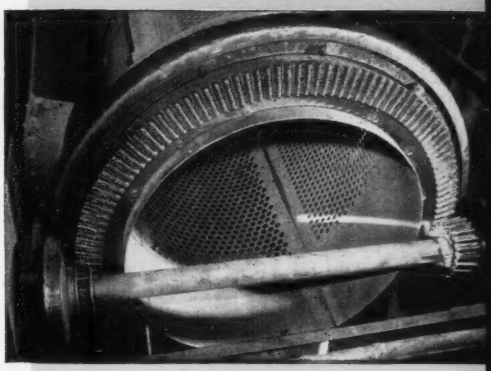
7. It can be cast in intricate shapes not normally feasible for cast steel.
8. It is generally more corrosion resistant than cast steel.



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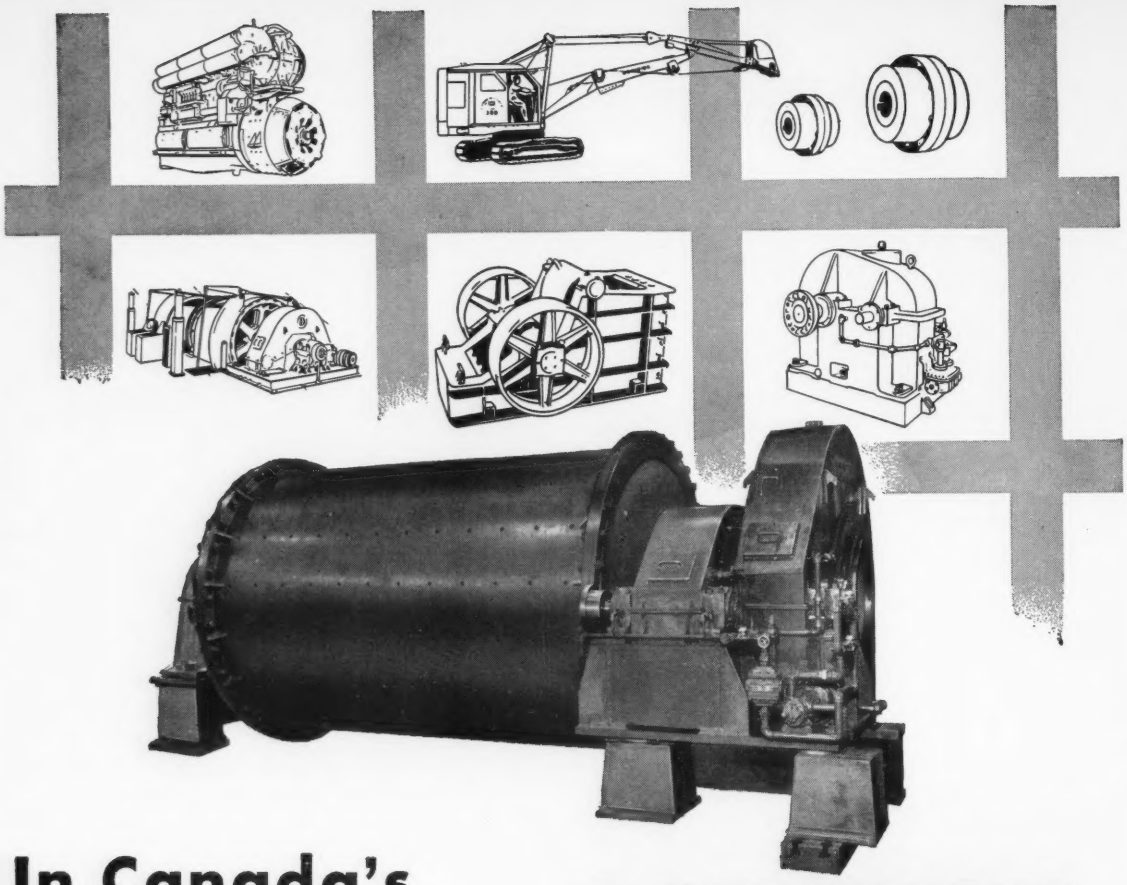

In Canada's mining industry DOMINION plays a major role

The totally Enclosed Drive Ball Mill shown here is a typical example of Dominion's mining equipment. Either totally enclosed or ring gear drive ball or rod mills are produced by Dominion in any size to meet specific requirements in the mining industry.

An impressive array of grinding mills, jaw crushers, mine hoists, giant conveyor drives, anode casting machines and sintering machines have established Dominion's standing as a producer of advanced designs and a manufacturer of first class heavy equipment.

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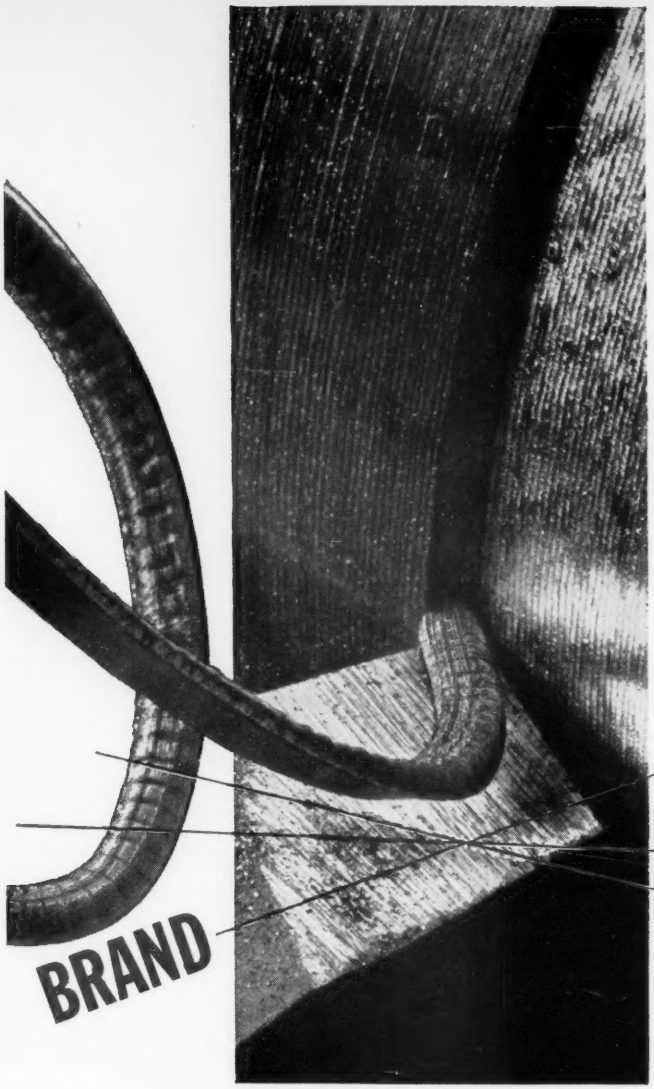

Shown is an Atlas Sabre tool bit hogging off a ¼ " deep cut at 75 surface feet per minute on annealed SPS 245.

NEW ATLAS SABRE BRAND

no other high-speed steel gives you all these advantages

Now a new super-high-speed steel—Atlas Sabre—offers relative ease of grinding, superior edge strength and good toughness in the field of high-carbon high-speed tool steels. In addition, this grade retains the normal advantages of exceptionally high wear resistance and hardness of this class of steel. With its outstanding properties fully proven by laboratory and field tests, Sabre is now stocked in Atlas warehouses across Canada. It is available in standard tool bit sizes from ¼ " to 1" square, in hot rolled annealed bars and annealed forgings, in all standard sizes up to 12 square inches maximum cross section. Ask your Atlas representative to give you the full story on Atlas Sabre and how it can serve you effectively.

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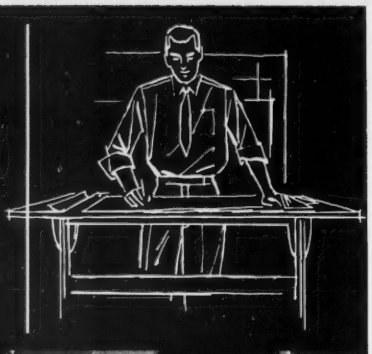

Dies are carefully hand-finished to maintain precision tolerances and high surface finish in the forging.

The operator of this die copying machine is making a duplicate die. This die will be used in a 3000 lb. drop hammer. It will produce more than 20,000 pieces, holding them to accurate, precision tolerances.

CANADIAN STEEL IMPROVEMENT recognize die-making as the key to precision forging and lower production costs. From the initial drawing—to the master die—to copies of the master die—every step is carried out with precision accuracy—to produce a quality forging.

CANADIAN STEEL IMPROVEMENT can forge parts to commercial, close or precision tolerances. In comparison to other methods, C.S.I.'s modern forging technique can save thousands of production dollars—literally cut delivery time in half. And most important—from the standpoint of product improvement—every part gains that immense structural strength which only quality forging can impart.

Take a critical look at your present part production methods. Take the parts to C.S.I.—see if they can't be forged cheaper—faster—stronger.

When finished, the dies are heat treated under careful control to obtain the required hardness and tensile properties.

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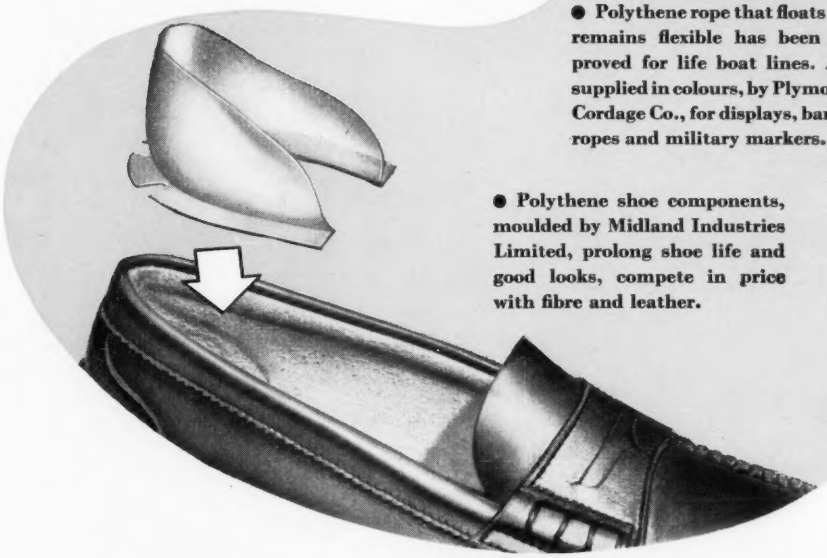
Now they're making rope and shoe parts of flexible polythene

● **Polythene rope that floats and remains flexible has been approved for life boat lines. Also supplied in colours, by Plymouth Cordage Co., for displays, barrier ropes and military markers.**



● **Polythene shoe components, moulded by Midland Industries Limited, prolong shoe life and good looks, compete in price with fibre and leather.**

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It's a light, tough, flexible material which has an unusual number of outstanding physical and chemical properties. Polythene is moisture-proof, corrosion resistant, non-toxic and chemically inert. It remains flexible and strong even at sub-zero temperatures, has excellent dielectric properties.

Polythene is currently at work in industry for such widely divergent products as film and moulded packages, flexible pipe, packing rings, carboys, spring liners, battery parts and electrical insulation. Consider this versatile material in relation to *your* particular operation and problems; it may be the key to greater efficiency, reduced costs, increased sales. For further information or technical assistance, write Canadian Industries (1954) Limited, P.O. Box 10, Montreal.

Look for new products, new developments in the pages of the C-I-L "Plastics Sphere".

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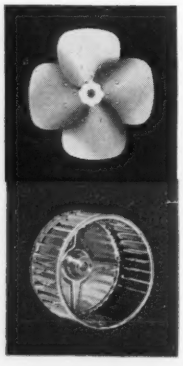
The "S Series" fan blade represents only a small portion of the unusually broad variety of air impellers which Torrington produces for heating, ventilating, refrigerating and air conditioning equipment. This product range and manufacturing capacity can provide... quickly and at low cost... the fan blade or blower wheel best suited to your air-moving requirements. Torrington has extensive research and test facilities which are available to assist you in the solution of design problems relating to air flow, sound and vibration. No one has had more experience in the design and production of air impellers than Torrington. Nowhere else can your dollars buy so much in terms of product quality and customer service.



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VIP's

Important people who are in the news

FORTY YEARS AGO energetic **Dr. F. X. T. Berlinguet** of Three Rivers, Quebec, retired from the Dominion Department of Public Works at the age of 60. He had no wish to do so, believing that to work is to live. He turned to land surveying and spent the next 37 years busily proving the rightness of his theory.

Three years ago he decided he had worked for man long enough, abandoned his surveys and settled down to what is described as "almost continuous prayer."

Although his chief interest had become God he continued to keep clear eyes on the to's and fro's of modern life around him and particularly on the Corporation of Professional Engineers of Quebec—of which he is a charter member. This year he decided to attend the Corporation's annual general meeting in Quebec City. When members of his family objected, he slipped away, took a taxi to the station then a Pullman car to Quebec; none of his fellow-travelers guessed that the white-haired sharp-featured passenger riding with them was 100 years old.

It was a different story when he arrived at the meeting. He became hero of the year, was given a certificate of honor and resounding applause which a spectator described as: "Very breath-taking. The whole audience applauded and went on applauding; then they sang 'for he's a jolly good fellow.'"

The old man was deeply touched, waved his hands to acknowledge the storm of affection.

He has a simple explanation for his long life. "It comes," he says, "as a gift from God." Other factors may have played a part: Dr. Berlinguet is a non-smoker, non-drinker, vegetarian and an immensely hard worker who has never taken a vacation in his life. "We take too much rest," he once said. "It is harmful."

Perhaps the strangest touch to the long life story of Quebec's Berlinguet (and Canada's oldest engineer) is that he has always been frail and twice nearly died at about the age of 30.

• • •

ONE OF THE Canadian electrical world's most colorful figures stepped from an active role this month to end an outstanding engineering and executive career that spanned 46 years. **Harold A. Cooch,** who rose from a 16-cent-an-hour apprentice job to become head of the second largest electrical manufacturing firm in this country, retired from his post as Board Chairman at the Canadian Westinghouse Company. Behind him lies a series of contributions to engineering science that is reflected in many big power generating projects in Canada.

Toronto-born (in 1888) Harold Cooch received his first taste of the electrical industry when he wound generator coils as a summer apprentice at the Westinghouse plant at Pittsburgh. He was then a University of Toronto engineering

Stepped from an active role

student. When he graduated, his degree thesis predicting the increasing need for direct-current for electrolytic work and the extensive use of new mercury arc rectifiers for that purpose appeared as extracts in the Applied Science Magazine.

Harold Cooch has been nationally known for more than 40 years for his efforts to promote the growth of the electrical industry. He served with distinction in World War I and was largely responsible with the late Joseph T. Thwaites for the development of Ignitron rectifiers which made possible the mass production of aluminum in World War II. The increased aircraft production of this country was one benefit of this development.

Graduated with a Bachelor of Applied Science Degree in 1910, he remained at the university to lecture in third year electrical engineering. His two years on the faculty won him the nickname "Fac" as he was the first member of his Theta Delta Chi Fraternity to teach on the university staff.

Retiring from active service in March 1919, he resumed sales work at the Toronto office of Canadian Westinghouse. His successful negotiations with the Toronto Transportation Commission, Ontario Hydro, the T. Eaton Company and other large organizations won him promotion to his company's head office at Hamilton in 1923. In 1938, he became a vice-president and subsequently sales manager as well. When the company president, John R. Read, retired in 1949, H. A. Cooch was elected president and, a year later, chairman of the board.

It was in his years in Hamilton that he entered into every important negotiation for power generating equipment in Canada. He watched the slow proof of a conviction born in him more than a half century ago, that this nation's abundant water power spelled a great future in the development of electric power for homes and industry.

He regards as the most "prodigious" of power projects in Canada in his lifetime, the new and yet unfinished Sir Adam Beck No. 2 Power Station at Niagara, with Kitimat second.

Believed that to work is to live

IT'S WESTINGHOUSE...

NEW Life-Line A

THE WORLD'S BEST MOTOR

FOR INSTANCE . . .
THE NEW ARMOURIZED HOUSING

. . . a product of years of actual motor pioneering by Westinghouse! Westinghouse tested them all and gives you the best. The new armourized cast iron used in Life-Line A motors gives the best housing protection and the most versatile design.

YOU CAN BE SURE . . .
IF IT'S Westinghouse

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55B100

An X-ray of an Orenda engine casting is studied before machining. Greatly reduced waste can be won this way.

Use X-Ray Before Machining Instead of Only for Final Inspection

By G. E. NEAPOLE
FERRANTI ELECTRIC LTD.

Is the best use made of industrial X-ray? Not when it is restricted to final inspection! The following pages urge that X-ray should come earlier to cut waste, lower cost

.....X-ray is one of the most revealing of all test methods available to industry

THROUGHOUT ITS HISTORY, almost to the rearmament period, there has been with a very few (but notable) exceptions, a strong tendency to look on the x-ray as being only a final inspection tool; or a device to assist in deciding whether an expensive completed part should be used or junked.

This wasteful situation is now changing, for more and more components are being inspected before any machining takes place. More important still is the fact that designers are becoming aware that on repetitive parts particularly and where final x-ray inspections are not mandatory, an even more economical use becomes sound. It might be called the quality control application in which pilot parts are made, inspected and remade until techniques are improved to the point that the end product is almost certain to be sound. Final inspection can then be carried out at much lower cost on a spot or percentage basis. The reasons for the lower costs hinge on the varied apparatus available.

The x-ray is one of the most revealing of all methods. It would be of no particular value to the design engineer if methods for investigating and reporting on the internal condition of his parts resulted in their destruction. True enough that he might get some guidance this way, but he would still be in doubt about the condition of the parts not so tested.

Almost inseparable from the many other problems facing most designers are those of size and weight reduction without loss of the required strength or safety margins. These problems very naturally become more acute as planned stresses rise. They even have some importance in the design of the castiron kitchen range; but their importance in the equation of compromises governing the design of parts for such things as aircraft, pressure vessels and other highly stressed structures, is immense.

If the designer could predict accurately the internal condition of the various components he proposed using in his overall design, his worries would be greatly reduced. Besides reducing size and weight, the designer is expected to create shapes and specify materials which, even though stresses may be low, must result in a minimum of waste during the manufacturing process and at the final inspection. Many components require machining or other operations which may in some cases run in value to a hundred times the worth of the unworked piece—only to be rejected after so much money has been spent on them.

The usefulness of x-rays was demonstrated shortly after Roentgen discovered, studied and produced it at will. But it did not (chiefly because of its weakness and uncontrollability) come into anything like common use until World War I when it was widely used to inspect aircraft parts—both wood and metal. Then it again fell into the closest thing to disuse.

The perfection of the welded pressure vessel brought it back because of its very great value in reporting on the internal conditions of the completed weld. Its use quickly became mandatory for welded pressure vessels over certain sizes, wall thicknesses and pressures. It became of value not only as a final inspection tool but also as a method of improving the metallurgy and the quality of the welding techniques.

Rapid increase in the design and construction of faster and heavier all-metal aircraft boosted the number of its uses greatly. In fact it was not long before its use on certain highly stressed aircraft components also became mandatory. World War II probably quadrupled the number of industrial x-ray units in use in Canada in the interval of about four years. It became of top importance in making sure of a high degree of perfection and safety not only in aircraft but in tanks, shell fillings and fuze parts, rocket fillings, gun parts and in the latter stages of the war, welded ship hulls. And the list of course, is longer than this.

After the war, almost up to the time of Korea, the struggle to convert to peacetime products took so much attention that the accent on quality dropped somewhat away and little or no expansion took place in the use of x-ray as a non-destructive testing device. But acceleration in the pace of arms production during and after the Korean episode, together with a rapid increase in welded pipelines, brought a marked increase in its use; this has continued steadily.

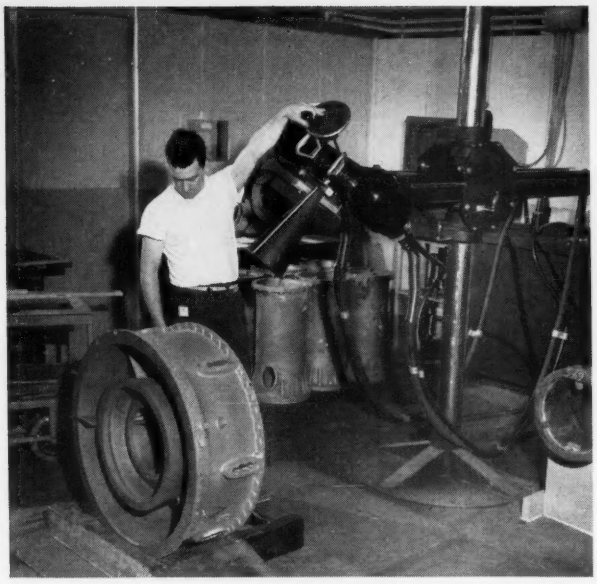
It need hardly be pointed out that there is no x-ray unit available which will produce the best results in all industrial activities. They come in different sizes, shapes and capacities, tailored to suit industries' special needs just as closely as possible. There are three main types: the portables, in various work capacities, designed mainly for field, pipeline or shipyard use in all weathers; the mobile, in a number of capacities for indoor work on large, heavy and relatively immovable specimens such as castings and pressure vessels; and the stationary units designed for work on specimens which can be moved to the x-ray room.

Without exception they are graded

Almost without exception they are graded in terms of the kilovoltage which they are capable of applying to their x-ray tubes—the reason being that there is a marked relationship between this potential and the penetrating power of the unit. The higher the kilovoltage the shorter is the wave-length of the resulting X-radiation and the shorter the wavelength the greater is the penetrating power. Additionally, results largely depend on the relationship between the kilovoltage used and the thickness or density of the specimen. There is an optimum kilovoltage for every combination of thickness and density. If kilovoltage is too high for the selected specimen the contrast will be low. If kv is too low the exposure time will be excessive and contrast will again be poor. Therefore it would be wasteful to use a unit with capacity greater than the maximum required by the application and next to useless to use one lower.

So there are stationary and mobile units with kv ratings up to 50 for use on very thin sections of light alloys; portable units with ratings from 120 to 250 kv for field work on steels from ¼ in. up to 3 in. thickness and stationary units up to 1,000 and 2,000 kv for steels up to 8 in. or more—although these are rare and very little used in Canada. The most generally used are 175 kv portable for pipelines and ships, 150 kv mobiles and stationary units for smaller pressure vessels, and smaller or light alloy castings respectively, and the 250 kv mobile or stationary units for heavy vessels or heavy castings.

It is not possible to state exactly what kilovoltage will give satisfactory penetration through which material —and tables which claim to do this may be misleading. The needs differ so widely in each case and the quality of radiation from each particular design of unit varies so considerably, (no matter what the kv rating) that an



This engine casting looks sound. But is it? X-ray unit here being focused looks below surface to decide.

method cannot (yet anyway) replace the radiographic system.

With the development of devices like the Westinghouse Image Amplifier this situation could change overnight. And of course the present fluoroscopic method does have very useful work to do on the lighter alloys for instance when radiography is not mandatory, and where the manufacturer is interested in ensuring that his product is free from gross internal imperfections at least. There are two or more very fine examples of 220 kv industrial fluoroscopes in active and important use in Canada. But it is wise to keep in mind that the fluoroscopic method, without vast improvement which will take time to come, cannot and will not entirely replace the radiographic method.

The x-ray method of non-destructive testing is not the perfect system. It cannot reliably detect laminar discontinuities running at right angles to the x-ray beam. Hair-line cracks are discernible only if in a plan parallel to and on the central pencil of the x-ray beam, and then only with difficulty. X-ray units of reasonable size and price (250 kvp) are capable of yielding 2% sensitivity through a maximum of 4 in. of cold rolled steel under favorable conditions but minute surface cracks are not usually revealed. It is, generally speaking, the most valuable of the non-destructive methods, but it is important that its limitations be known and kept in mind.

A unit should not be bought until the job it has to do is fully understood . . .

x-ray unit cannot or should not be bought until the job it has to do is thoroughly understood by the seller and the capabilities of the unit, with all factors expressed, are fully understood by the purchaser. Specimen shapes also have a notable effect on the resulting radiograph. In addition to the sizes, shapes and kv ratings available, there is a further variation depending on whether the unit is to be used for continuous or heavy duty operation or for intermittent or light duty. The heavy duty ones are more massive and expensive, using in most cases a rather elaborate pressure oil-cooling system for the tube. The light duty ones can be lighter and generally less expensive. So for quality control at the source on pilot models, a considerably less expensive x-ray unit may often be used. On 100% inspection the unit is usually called on for almost continuous working and so must be of the heavy duty type. On spot or percentage checking it can often be of the lighter duty type.

So far, only x-radiography has been considered. This term means that the x-ray has reported what it sees on a photographic film. It can report also in a quite different way. Certain "salts" fluoresce, emitting light when excited by x-radiation. Thus they too, when spread out on a fluorescent screen, will give a picture or shadowgraph of the object being examined. Because many people have seen medical screens in use they feel that it should be a good method to use in industrial applications to cut down on the high film consumption associated with the radiographic method. Unfortunately this is not often the case, partly because the authorities who have made X-radiography mandatory insist quite wisely on the maintenance of picture-records and partly because the screen does not yield the required sensitivity; and further because the radiation protection problem becomes much more complex. So the fluoroscopic

Supplementing it very adequately are the magnetic particle and fluorescent particle and dye methods for surface defects; radioactive isotope radiation (sometimes referred to as gamma-graphy) and the betatrons for thicknesses up to 12 in. of steel; the supersonic echo-type instruments for thickness (or lengths) up to 20 ft. or more; and the eddy current devices for surface and constituent defects and the whole range of strain-gauging methods.

There is overlap on all the various systems and on very critical applications as many as three or even four methods may be used to ensure that quality is as close as possible to perfection.

At present there are about 60 firms in Canada using x-ray apparatus on industrial applications. They are divided as to capacity and type, roughly as follows:

Portable & Mobile—50%; stationary—50%; 0 to 150 kv—12%; 150 to 250 kv—80%; 250 to 400 kv —8%.

People who are interested have formed themselves in the Provinces of Ontario and Quebec into two new Sections of the Society for Nondestructive Testing Inc., with headquarters in the U.S.A. While all forms of non-destructive testing are covered, a large portion of general meeting time relates to the use of X-radiation. This information was introduced to show that the art had gone a long way toward perfection and is indeed here to stay and to expand as a device to assist the design engineer.

St. Paul summed up the design engineer's technical responsibilities pretty thoroughly long ago: "Prove all things" he said. "Hold fast that which is good." The x-ray makes it much easier to be sure of doing this. It is an important tool. ★

This New Sheet Insulation Is Twice as Strong as Any Other Film

A new film now on the market has great strength and high insulation value. It has much to offer—including the way to make electrical products smaller

By J. C. Cawley
Du Pont Company, Canada

A BRAND NEW plastic film that has properties even better than those once thought ideal is now reopening old fields and creating new ones for the design engineer.

Mylar, developed by Du Pont and now ready for use in Canada, looks for all the world like cellophane. But it packs an impact strength almost twice that of any known commercial film. And it boasts a tensile strength one third that of steel.

Already it has found a place in many industries. It is now being used, or is about to be used, in dozens of products. They range from electrical insulation to sound recording tape, from children's kites to capacitors and from acoustical tile to transformers. But engineers, excitedly putting the new material to test, have only begun to probe the possibilities.

Mylar grew out of research that followed the discovery of nylon. Du Pont wanted a chemical combination that would give even stronger polymers. A research team headed by Dr. Herman F. Hoerig, manager of Du Pont's Canadian research and development department here, found the answer.

The team developed a solid substance with an unusually high melting point. It was formed by the condensation reaction between ethylene glycol and terephthalic acid. Dr. Hoerig and his associates found they could form this polymer into a transparent and highly flexible film. The chemicals, derived in part from petroleum and natural gas, make the film a chemical twin of Dacron polyester fibre.

When the Du Pont scientists had fully developed and tested their new material, they discovered it had properties never before found together in one plastic. The Mylar now on the market has these features:

- It is insensitive to moisture.
- It resists solvent and chemical attack.
- It has, even in thin sections, a dielectric strength greater than that of any known insulating material — about 4,000 ohms per mil.
- It has a range of thickness from ¼ mil. (0.00025 in.) to 7.5 mils (0.0075 in.), without sacrifice in strength.
- It has a tensile strength of 23,500 psf, about one third that of machine steel.
- It can be used in a temperature range from —60 C to 150 C, without losing strength. This is because it has no plasticizer or other additive to migrate after long exposure at high temperature—and because it contains no material likely to crystalize at low temperature.

Added together, these properties go away beyond those once considered ideal for flexible plastics and insulating materials. Considered together, they give rise to hundreds of new opportunities for alert engineers.

The company sells Mylar in a number of gauges, and in three distinct types, which it calls "A" film, "C" film and "D" film. These are basically the same, but have slight changes to fit them for special purposes. The purposes:

A film: This has a low electrical fault count (a measure of pinholes or spots of dielectric weakness) and is designed for general use as an insulation and dielectric material. You can also put it to many nonelectrical uses when a strong, durable material is wanted and surface static does not matter. It is made in gauges of ¼ mil, ½ mil, 1 mil, 1.5 mil, 2 mil, 5 mil and 7.5 mil. The thinner gauges are transparent. The 5- and 7.5-mil gauges are translucent.

C film: This also has a low electrical fault count, plus a high temperature insulation resistance that makes it suitable for packaging. In the electrical field it will be used mainly as a dielectric in high temperature capacitors. It is made only in ¼ mil, ½ mil and 1 mil gauges.

D film: This highly transparent film is made in the

This moisture-proof film leads to big

The new polyester film (here shown being factory rolled) is strong, resistant, a good insulator and transparent.

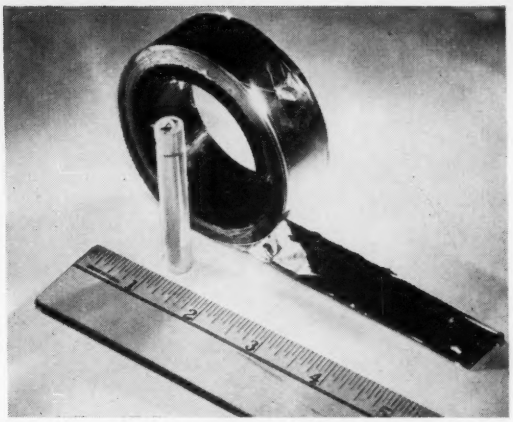
heavier gauges of 3 mil, 5 mil and 7.5 mil. It has few surface defects and is used for plastic glazing and for very many other jobs that take a heavy, transparent material.

All three types lend themselves to exciting new uses. Here are 10 ways Mylar may be used: in capacitors; in electrical insulation; as dielectric material for backing mica; in furnishings and floor covers; in the textile industry; for sound recording tapes; as pressure sensitive tape; in drum liners; in the leather industry, and in the packaging field. But Mylar is not limited to these fields—its possibilities are still wide open.

The end of a quest. Mylar may be the end of the electric industry's quest for a new capacitor dielectric. For years the industry has been plagued by holes, conducting particles and moisture sensitivity in the thin gauge paper it has been using. Several designs now use Mylar as a capacitor dielectric, and more may do so soon. It has these advantages:

1. Freedom from electrical faults or spots of dielectric weakness.
2. Twice the dielectric strength as the same thickness of paper.
3. Insensitivity to moisture.
4. Lower power factor at operating temperatures.
5. Better high-temperature insulation resistance.
6. Greater physical strength—it winds without tearing or bending.

Some manufacturers now believe that, because Mylar is moisture-proof, capacitors wound with it will not need an impregnating varnish—unless they're designed for a working voltage above the corona starting level of about 400 volts. You can eliminate the corona air voids to a great extent by shrinking the Mylar—that is, by heat-treating it at about 150 C. This takes advantage of the fact that Mylar shrinks from 3 to 5% at this temperature. The process results in a very tightly wound unit.



The new film means smaller parts. This capacitor is made of .00025 in. film and 1-millionth in. aluminum.

You see the importance of Mylar's temperature range when you consider that a paper dielectric capacitor usually has a temperature limit of 85 C. Mylar operates well at 150 C. (For minimum performance ratings for single-layer capacitors wound with 25-gauge "C" film, see Table 2.) **(Continued over page)**

changes in products ranging from electric motors to leather work and floor covers

polyester film has this to offer:

It is strong

Tensile strength		23,500 psi
Break elongation		70 per cent
Impact strength		90 kgm-cm
Bursting strength		45 psi
Tear strength	(at 25 deg. C)	20,000 cycles

It is good electrically

Dielectric strength	(25 deg. C 60-cycle)	4,000 volts/mil
Dielectric strength	(150 deg. C 60-cycle)	3,150 volts/mil
Dielectric constant	(25 deg. C 60-cycle)	3.2
Dielectric constant	(150 deg. C 60-cycle)	3.7
Power factor	(25 deg. C 60-cycle)	0.003
Power factor	(150 deg. C 60-cycle)	0.0064
Insulation resistance	(100 deg. C 60-cycle)	5000

It is good chemically

Moisture absorption	(immersed 1 week at 25 deg. C)	0.5%
Moisture vapor, permeability		160 gms/100 sq m/hr
Fungus resistance		inert
Copper corrosion		negligible

It is good thermally

Melting point	250-255 deg. C
Service temperature	60-150 deg. C
Shrinkage (at 150 deg. C)	3-5%

Sheet insulation *continued*

Metalized Mylar has also been wound successfully into capacitors. It is expected that the performance here will equal that of capacitors using film and aluminum foil.

Cheaper motors. Reduced costs may be the result of using Mylar as insulation for generators and motors. Its special properties permit the manufatcure of slot insulation, phase insulation and wedges at lower cost.

Film in thicknesses of 1, 2, and 5 mil is now in use as insulation for transformer coils between layers turn-to-turn and also as the outside dielectric wrapper for the coil.

For transformer design, the properties needed are toughness, dielectric strength, thermal stability and moisture sensitivity. Mylar now competes with such materials as paper, varnished cambric, silicone rubber, asbestos, mica and various laminations of these materials. Its high dielectric strength in thin sections means that you end up with a smaller coil. And Mylar film laminated to asbestos has worked well in transformers.

Also, narrow strips of the film can be used in voltage regulation and solenoid coils to insulate the coils from each other and from the ground.

Tests show that Mylar succeeds as a separator, as a barrier and as primary insulation material in multiconductor cables. The function of a separator is to form a wall between the conductor and other insulating material. You can apply Mylar directly over the conductor, either parallel to it or wound spirally; in both methods you use an overlapping joint. This serving of Mylar prevents the other insulating material from getting between the wire conductors. It also allows a flexible conductor, because of the good slip in Mylar. The additional advantages as a separator are that the film is not porous and that its strength permits winding at high tension. The thin film gives a smaller final cable.

A barrier material that is to stop saturants moving from layer to layer of the insulation in cable construction must have a high tensile strength (for tight wrapping), moisture insensitivity, thermal stability, chemical resistance and high dielectric strength. Mylar is strong in all these.

The wire and cable industry is now also considering Mylar as an insulation for magnet wire. Several designs on the market now have a magnet wire served with a lamination of Mylar and asbestos.

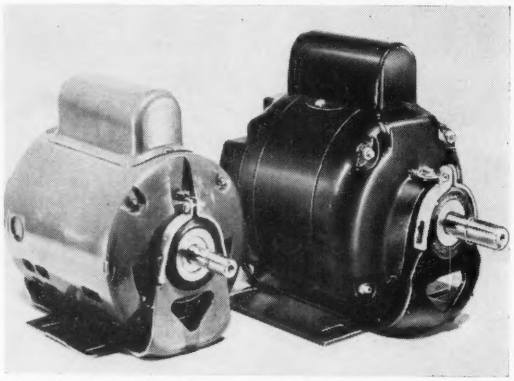
Mylar comes forward. Mylar is now replacing paper, Cellophane, cellulose acetate, silk, cotton and synthetic fibre cloth as a carrier for backing mica. But it will not be able to replace fibre glass, cloth or asbestos.

The new product's top advantage in this field is its high mechanical strength. This permits rough usage in winding large motor or generator coils. Here, as in other uses, the high dielectric strength allows thinner mica splittings.

Mylar at home. Mylar is finding new uses in the home. Because it will take a wood grain print well, it can be laminated to plywood to make handsome, low-cost furniture. Reverse-printed Mylar can be laminated to table tops to give them an attractive moisture and scratch-resistant surface. Other possible uses include TV cabinets, wallpaper and wall paneling.

The film can be laminated to acoustic tile, dyed, or printed in attractive patterns. It is practical because it will not catch dust easily and because its smooth surface can be quickly wiped with soap and water.

The new strong and inert polyester film is ideal for phase insulation and slot lining in electric motors.



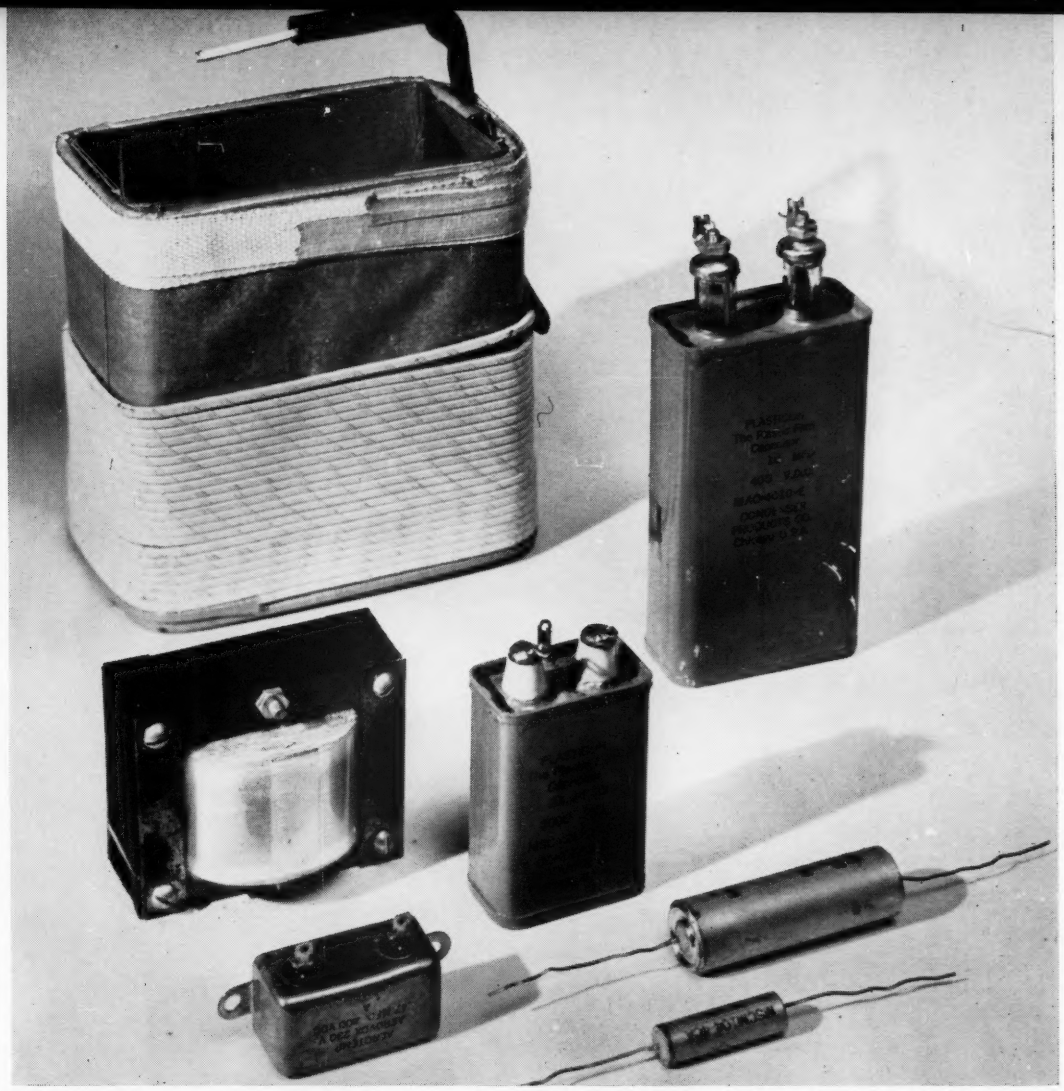
Mylar means smaller motors without any loss of output.

Textile men aroused. Metallic yarn made from Mylar has won much interest from the textile industry. To produce this, aluminum foil is laminated in wide rolls between two sheets of thin Mylar and then slit to very narrow widths—1/64 inch or 1/80 inch. The resulting yarns are strong and non-tarnishable and will withstand washing, pressing and dry cleaning. They are used to give metallic decorative effects in women's clothing and also in draperies, handbags, shoes, gloves and upholstery.

High temperature tape. The advantages of Mylar in sound recording tapes are that the tapes hold out against extremes of temperature and humid air and can be used many times or stored for long periods. The fact that Mylar contains no plasticizer means that the film will not dry out to become brittle.

The pressure-sensitive tapes now being made with Mylar are stronger than other film tapes and resist chemicals and abrasion better. You can use them for bundling, masking, splicing paper and plastics (where good solvent resistance is necessary), sealing cans and tubes and for etching and covering.

Seep-proof drums. When you laminate the fibre-type Mylar film to a drum it form a moisture-resistant and chemically inert surface. Even oils and greases as



Polyester film is good insulation. It is used in coils, capacitors (dry and liquid filled) and transformers.

penetrating as lard, cottonseed oil and motor oil will not seep through 1 mil Mylar after two months of exposure at room temperature.

Also, Mylar resists most acids, alkalis and solvents. This means Mylar drum liners can be used to ship corrosive chemical that would otherwise cause fibre or metal drums to deteriorate.

The new plastic's excellent heat resistance also allows the lined drums to be filled hot. Such solvents as ethyl acetate, methyl ethyl ketone, and naphtha will not markedly affect Mylar at room temperatures or even near the boiling point. At room temperatures, the permeability to such solvents as methanol, ethyl acetate, carbon tet, hexane, benzene, acetone and acetic acid is virtually zero.

For glamorous clothes. Leather goods manufacturers are now applying a thin sheet of Mylar to the outer surface of evening shoes, handbags and belts to get a subtle metallic shade.

Before they laminate it, they subject the plastic to high vacuum conditions in contact with aluminum vapors. These vapors condense on the film in a very thin layer; the process is called "metalizing." The result: The original grain of the leather shows through a subtle sheen, which lasts indefinitely even with hard wear.

There are other advantages: the leather wears a long time because of the plastic's abrasion resistance; and it can be cleaned with cleaning fluid without affecting the color or sheen.

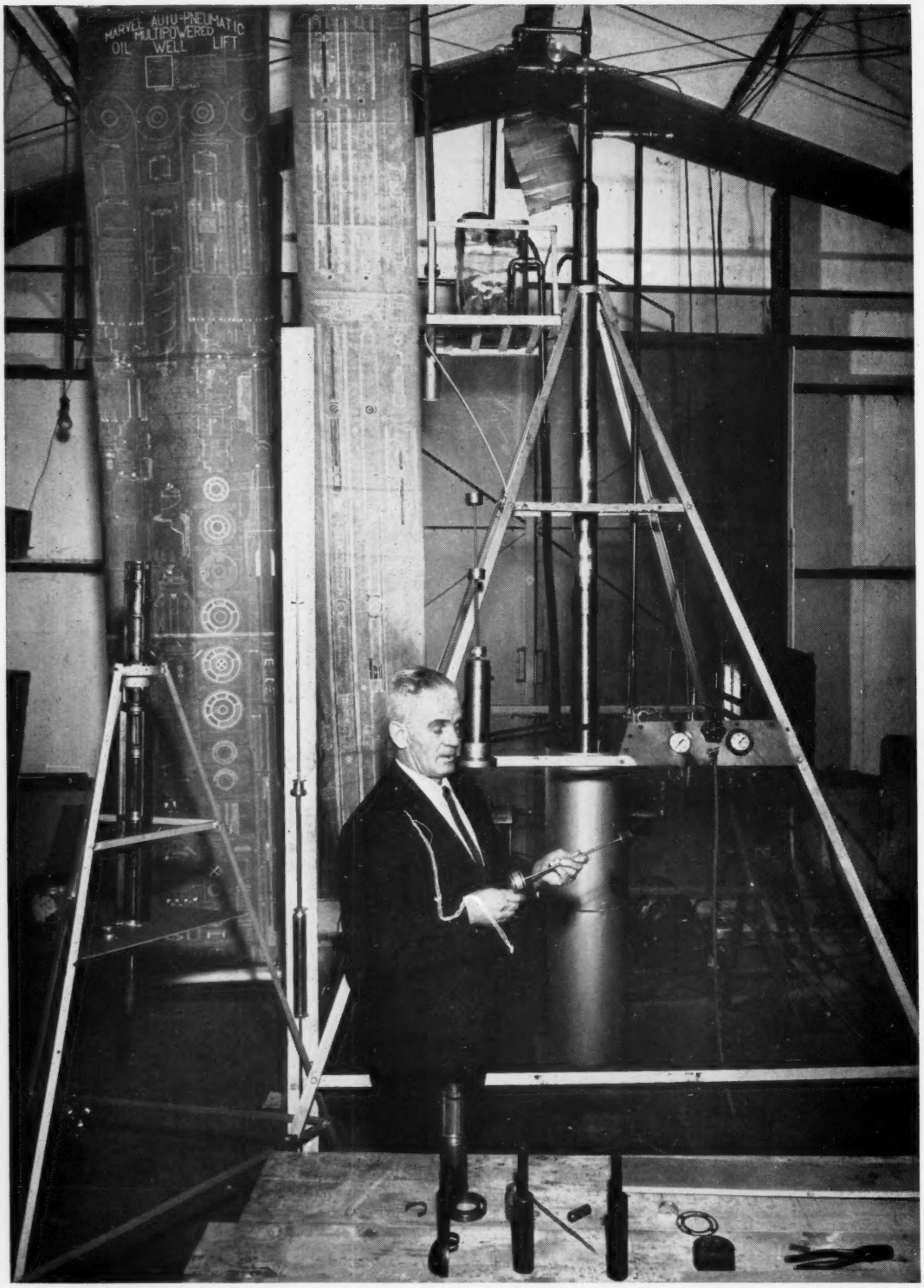
Metalized Mylar can also be laminated to fabrics and vinyls, and the lamination can be embossed. The auto industry is now using Mylar for scuff panels on car doors, around the door handles, and on the tops of seat covers.

Someday for packaging. Eventually, Mylar is expected to play a major role in packaging. The present product is hard to seal, but research now being carried on is expected to improve it in this aspect.

Items that have a fairly long life on store shelves are candidates for Mylar packaging. The new film will eliminate the broken packages caused by other transparent films becoming brittle. It is expected that results of the experiments that will make Mylar a valuable packaging material will be released this year.

What about that kite? Well, one enterprising toy manufacturer has produced what it claims is a crash-proof toy kite from Mylar. Among the company's proudest boasts is that the kite can be flown in the rain. But of course, to Mylar which can do so much, resisting raindrops is a walkover. ★

This Economy Oil-Well Pump is All-New



James Green's first model pump was lost in a 1951 fire; so he built another — seen behind him in this picture

And . . . All-Canadian

By Ron Anderson

No-one has found a way before to make natural gas pressure work an oil well pump. But a Westerner has done it now

A NEW TYPE of oil well pump, operated entirely by the pressure of natural gas present in the oil bearing formation, has been developed in Calgary by James Cecil Green, a veteran of the Turner Valley Oilfield. The pump has two new features. Firstly, the total force exerted by gas pressure in lifting the column of oil in the wall casing is magnified by having a larger area acted on by gas pressure. This is done by mounting a series of power units vertically in the well tubing, all bearing on a common shaft. Secondly, the power units and pumps are located inside the well casing near the bottom of the hole.

In conventional types of oil well pumps, the power unit—an electric motor or internal combustion engine—is at the surface of the well and a long shaft extends into the well hole to the pump. The length (and weight) of the power shaft often results in mechanical failure, particularly in deep wells. A simple type of gas lift has been used in some Alberta wells, in which oil is forced from one chamber to the next throughout the length of the well casing, until the oil reaches the well head, but the gas lift does not have a pumping action.

The principle of the Green pump may be seen from the diagram on the following page. A continuous string of 2-in. oil well tubing extends from the surface of the ground into the well to a packer-head (fig. A). This packer-head functions jointly as a subsurface control head for high pressure gas, for exhausting gas, and for oil being discharged from a pump below.

From the underside of the packer head, the tubing continues downward. This section of the tubing, which is 3 in. in diameter, is of special three-duct design. These ducts supply and exhaust power gas from the engine power barrels below, and provide a central upward passage for oil from the pump. The duct on the right-hand side has a top terminal under a pop valve housed in the packer head, where, if necessary, any excess gas may escape. A second arrangement of circular holes in the packer head form a terminal point of delivery for the left-hand duct, and are used in freely exhausting gases from the power barrels. So, exhaust gas bypasses the packer head and enters a chamber of lower pressure above. Oil from the pump passes upward through a central 1½-in. duct. The pop valve setting is 250 psi and this is therefore, the maximum differential pressure needed to work the power barrels. The section of the tubing is shown in fig. C.

The cross-sectioned view shown in fig. E is the pump unit. Cylinder walls of this unit are thick enough to the presence of four segregated annular ducts arranged around an internal cylinder. Of these ducts, Nos. 1 and 2 are used solely to supply and exhaust power gas to and from power units below, with no further restrictions, other than passing through open wall ports at cylinder extremities. Ducts Nos. 3 and 4 and used as pump suction and discharge channels, the latter channel being routed inwardly through an open port and so extended to the central 1½-in. duct referred to above.

When the combined assembly has been sunk to a predetermined level and the packer head set, the pump is under external pressure. The only means of escape for the gas is through the holes shown below the packer head in fig. A. The gas going downward in this duct reaches a distributor and moves the power pistons of the pump. Having done so, the gas is allowed to exhaust through duct No. 2 to reach the control head and bypass the packer head. In the event of a serious shortage of the gas supply in the oil well, power gas or compressed air can be brought down between two concentric strings of tubing, allowing the power barrels to exhaust into the annulars.

In steam pump engineering, multipower ratios are directly proportional to the areas of power pistons and pump plungers used. In an oil well pump, however, power units cannot be placed next to each other, because of the limited cross-sectional area of the oil well hole. So it is necessary in building up a variable multipower ratio to team up a series of power units, one above the other, on one centralized reciprocating member and then to tap this member for power delivery by a plunger of the pumping unit. This feature has the added advantage of being able to use a double-acting pump. Spool-type pump valves were designed to permit movement of the piston rod through their centres, without interference by drag.

The cross-section is small

Since the cross-sectional area is small, all the valves of this unit cut-off on ports, either by sliding or rotating. In power unit additions, open side wall ports service the working ends of each cylinder. This method of obtaining a variable multipower ratio, adaptable to the pumping needs of specific wells, is the key feature of the Green pump.

Neglecting frictional losses, the basic mathematical formula for the pump is as follows:

$$\frac{\Sigma A}{a} = \frac{p'}{p''}$$

Where ΣA = the total cross-sectional area of the power pistons (square inches).
a = the cross-sectional area of the pump plunger (square inches).
p' = the fluid pressure developed by the pump (psi).
and p'' = the engine-operating pressure, i.e. gas pressure (psi). If p'' diminishes, ΣA may be increased by adding power barrels.

The possibility of operational failure, either by short stroking or stalling in an ineffective service position, is overcome by driving the valves by an independent element. A schematic drawing of the valve gear may be seen at the top of fig. B. It consists of an energizing mechanism driven on the up-stroke by direct piston contact upon drive head "D" which stores up independent energy in the base of the valve gear. Release of the energy for driving the valves is co-ordinated with the positioning of a mechanical time lock, which functions only at the precise instant valves must shift for the next half-cycle. A hang-down, pull-out rod from the drive head "D" is allowed linkage movement within a hollow piston rod, the latter being required only within

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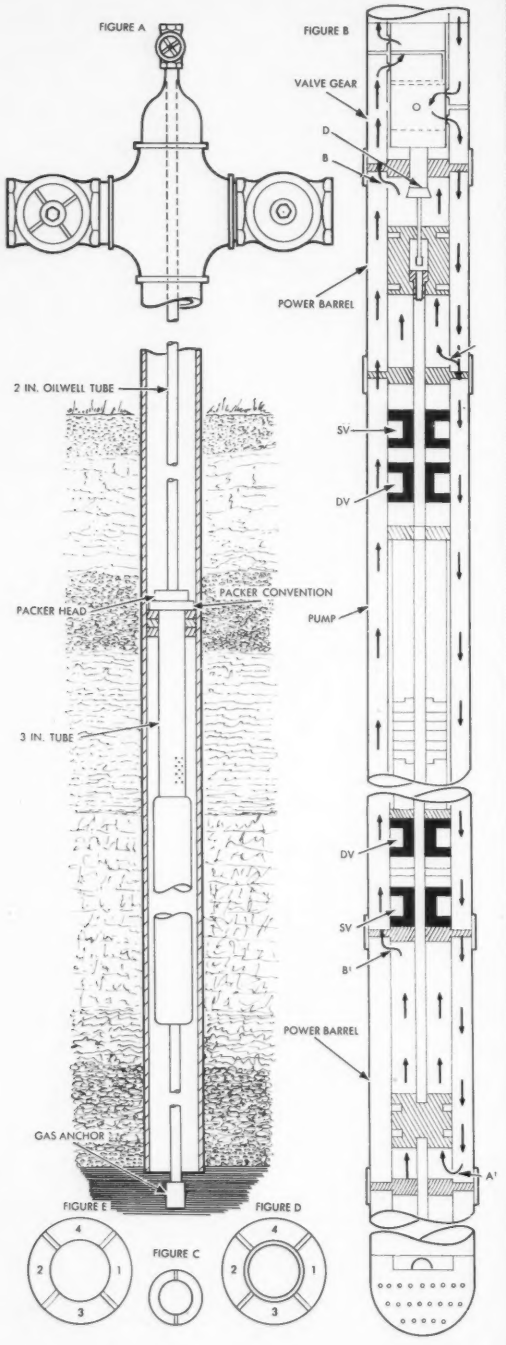


Two simplified sketches

Drawing (left) shows whole pump installed in an oil well. Right, the new valve gear and power barrels.

the first power unit, and is picked up again by the piston at the completion of the half-cycle. This causes the drive head to be pulled out again and re-energizes the element in the opposite direction for the next half-cycle.

The valve itself has two compartments and is of the rotating sleeve type, with holes cut through to match holes in the housing. Four valves are positioned instantaneously in each half-cycle, two of which are opened and two closed in a rotational cut-off movement. This arrangement simulates the function of a "D" slide valve in a steam chest, except that the movement can never be short of stroke and is instantaneous. The energizing mechanism runs in a bath of lubricating oil, and the sleeve valve rotates on ball races. The timing shoe, which gives instantaneous release to the valve, also keeps it mechanically locked in a fully servicing position, either on one side or the other. For this reason the inventor claims to have developed a positive locking valve-gear. The master valve-gear services all power cylinders through open wall ports, no matter how many cylinders there are in the assembly.

High pressure gas goes to No. 1 duct

High pressure gas passes down the control tubing and branches into duct No. 1. When reaching the valve gear, it circumvents a duct stop by looping inwardly through the low section of the valve, and outwardly to circumvent the stop (see arrows). This is made possible by having ports through the valve aligned with ports through the housing. Gas continues downward through duct No. 1, services the bottom ends of both cylinders through open ports A, A¹, and drives the pistons upwards. Meanwhile, exhaust gas from the previous half-cycle escapes through the left-hand side open ports B and B¹ at the top ends of the power cylinders, rises vertically through duct No. 2 and in a similar manner, circumvents the left-hand side stop by passing through an upper compartment of the same valve, and continues up the duct to exhaust the packer head. Completion of this stroke trips the valve gear for the next half-cycle. The valve snaps over to a new position where gas now travels diagonally through its lower portion to the left-hand side or duct No. 2, now routing the high pressure gas to the top ends of the pistons and causing movement downward. Meanwhile, exhaust gas now rises upward in duct No. 1, passes through a frontal open port at the top and into the same exhaust valve compartment as before, to take the same route as did exhaust gas in the previous half-cycle.

Fig. B shows the upper section of the pump on a discharge stroke and the lower section of the pump on a suction stroke. The notations DV and SV are for discharge valves and suction valves respectively. Of the four annular ducts, Nos. 3 and 4 are solely fluid ducts for the pump. No. 3 is the suction inlet, which eventually terminates over a ball check foot valve at the base of the combined unit. Pump valves have a sliding cut-off motion through open communicating ports. Discharge valves open directly into duct No. 4. Oil is eventually brought inward again to discharge beneath

(Continued on page 78)

An Electronic Detector Will Search For Unevenness

From electronics engineers comes more automation

By George M. Bornet, P.Eng.
ONT. RESEARCH FOUNDATION

A COEFFICIENT of variation integrator has been developed jointly by the Ontario Research Foundation and a Toronto firm, Electronic Associates Limited, to give automatically the coefficient of variation of a quickly and irregularly oscillating input. The instrument has been developed especially for a textile unevenness tester but is also suitable for use with other variable inputs.

When a continuous measurement gives a curve similar to the one shown here (see picture) it is often desirable to express its irregularity by a single number. Such a number can never contain all the information that is given by a continuous record because it does not bring out the shape of the curve, its periodicities and so on. If a single number has to be used, however, then the standard deviation, or its ratio to the mean, the coefficient of variation, is generally preferred as being the most efficient measure of irregularity. The standard deviation is obtained by squaring deviations from the mean and adding the squares. The squaring puts more "weight" on values further from the mean. This is desirable since it is the extremes which usually are the most interesting points and which often cause the greatest trouble in processing. The standard deviation and the coefficient of variation have many desirable mathematical properties which make them suitable for statistical calculations.

The standard deviation is defined as the square root of the variance which is the sum of the squares of the deviations of the observations from their mean divided by one less than the total number of observations:

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$$

The coefficient of variation is the standard deviation divided by the mean and expressed as a percentage:

$$CV = \frac{\sigma}{\bar{x}} \times 100\%$$

An equivalent and more convenient method of calculation is to take the deviations not from the actual mean x but from a provisional mean A. Also, if n is very large, then (n-1) is practically equal to n. The first formula then becomes:

$$\sigma = \sqrt{\frac{\Sigma(x-A)^2}{n} - (\bar{x}-A)^2}$$

In the above formulae σ = standard deviation, CV = coefficient of variation, n = number of observations in the sample, x = individual observations, $\bar{x}$ = mean of sample, A = provisional reference mean.

The calculation of the standard deviation directly from the curve is possible but is very tedious indeed. The SIGMA Integrator performs the work automatically. It gives the coefficient of variation by the theoretically correct procedure, outlined above. The integrator is hooked directly on to the variable output. A provisional reference mean is used at the centre point of a meter of the instrument. By a "sensitivity" adjustment, the curve for the particular output can be made to centre approximately around this provisional mean. The operator then switches the integrator on by a starting button and after 30 seconds it automatically stops. A longer integration time in multiples of 30 seconds up to five minutes can also be pre-set. During the 30 seconds the integrator takes 3,600 evenly spaced readings.

Two integrating meters are used. The 3,600 readings are summed algebraically by the mean meter and their squares are summed by the square meter.

In this way two quantities are obtained from the integrator.

1 on the square meter: the mean square deviation from the provisional mean—

$$p\frac{\Sigma(x-A)^2}{n}$$

2 on the mean meter: the mean deviation from the same provisional mean—

$$q(\bar{x}-A)$$

p and q are calibration factors.

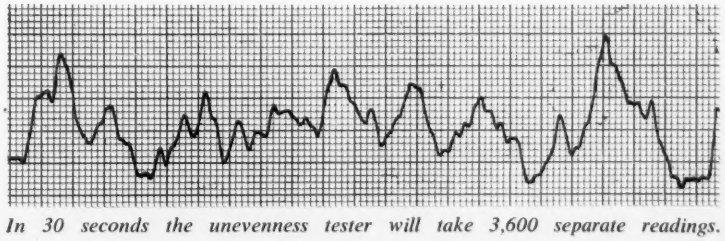
From these two meter readings, the standard deviation and the coefficient of variation are calculated by means of formulae **3** and **2.** In order to eliminate making the actual calculations, a graph has been developed for use with the integrator; having the two integrator readings, the coefficient of variation can be read directly off this graph.

The integrator works with high accuracy. Very good agreement was found to exist between values of the coefficient of variation given by the integrator and those calculated from the chart.

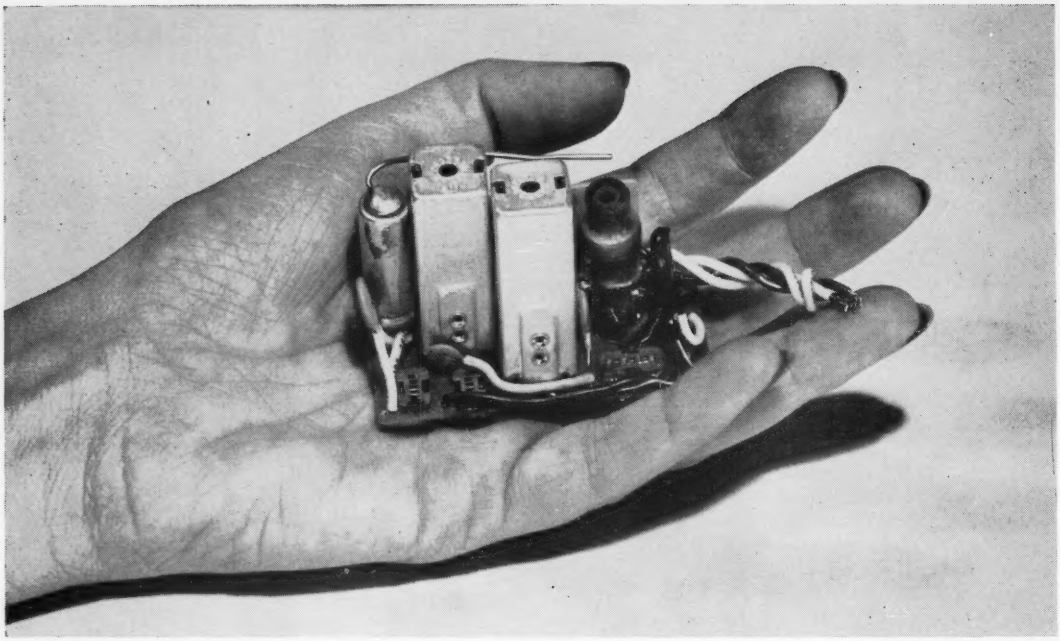
The problem of continuous measurement of irregularity has received much attention in the textile industry. Since World War II, a number of unevenness testers have been built which measure and record continuously the weight per unit length of a yarn or of an intermediate product of spinning. The measurement is done by one of several methods: passing the strand between plates of a condenser and measuring the

(Continued on page 78)

The new unevenness tester. Charted readings can be reduced to a number.



In 30 seconds the unevenness tester will take 3,600 separate readings.



A radio small enough to sit in the palm of your hand is easily made when wires are replaced with printed circuits.

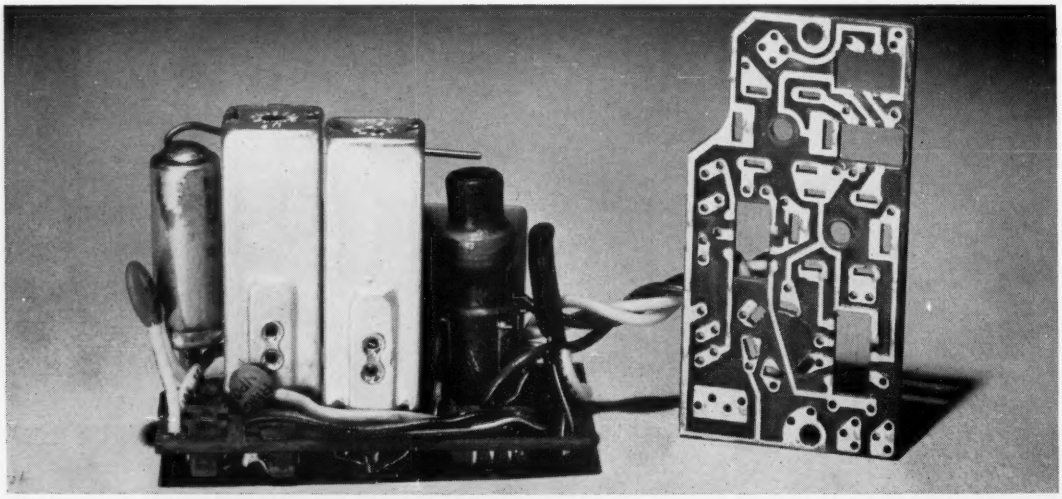
Printed Circuit is Big Wiring Change

Read the story of the most important wiring change in fifty years. It points to better, cheaper products

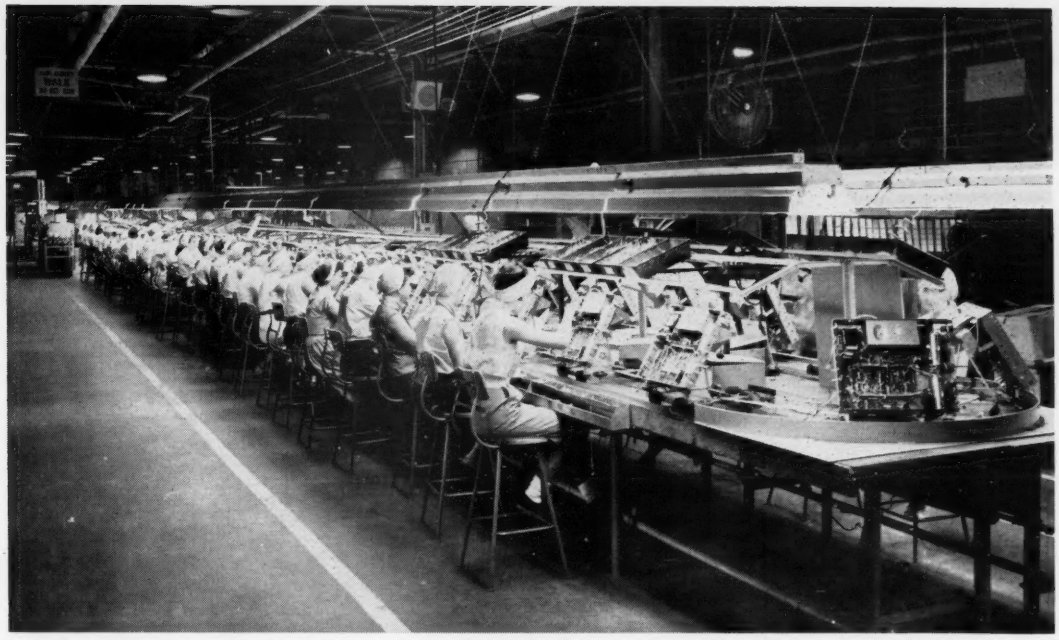
By Robert F. Bogart
NATIONAL FIBRE CO. CANADA

THE INVENTION OF printed circuits has brought the first big point-to-point wiring change of the past 50 years. And it is a most important change. It is leading quickly to better products and much simpler production.

Printed circuitry is the answer to the design engineer's prayer for electrical connections without wires. It cuts out the need for skilled labor, does away with the risk of error and makes automatic production possible. It is not just another way of doing point to point wiring; it is instead an entirely new idea which will soon



The heart of the tiny radio (shown above). Besides keeping it trouble free, the printed circuit gives it strength.



When complex wiring hook-ups become unnecessary, girls can take over the work of skilled men to lower costs.

revolutionize the design and manufacture of electrical assemblies and sub-assemblies.

Among the many products which are already being affected are radio and television sets, micro-wave receivers, electronic computers, hearing aids, pocket transmitters, timing devices, home appliances, industrial control and test instruments. Even guided missiles will be using these new circuits.

What then is a printed circuit? By definition, it is any electrical or electronic conductive pattern reproduced on an insulating support. Usually the conducting material is copper but other foils can be used too; silver, brass and aluminum are good ones. The insulating support is usually a laminated plastic. Often the circuits are plated with hard metals so that they wear well, solder easily and resist corrosion.

An extra advantage the new circuits give is smallness — a smallness that goes beyond the fact simply that they are compact in themselves. They also allow component parts to be better, more tightly arranged.

As electronic assemblies become more complex their sizes and shapes tend to grow unwieldy. Printed circuits, by putting all conductive paths into a single plane chassis, avoid the tangle of wiring that would otherwise be hard to avoid.

Weight is another point. Phenolite makes a good base; yet it is one third the weight of steel, half the weight of aluminum. If material like this is used, it acts as both conductor and structure to give a wonderful compactness with very light weight.

For evidence, look at the tiny radio by Electralab Incorporated. It is small enough to be held in the palm of the hand and its printed circuit measures just 2 5/16 in. by 1¼ in., yet its range is so good that a polar expedition chose to carry it recently. This set (it is fitted with sub-miniature hearing aid tubes) is a fine example of smallness coming from a single-side printed circuit chassis. All the components are mounted on one side of the panel with leads protruding through. The connections were made by one dip soldering and the conductors were later roll coated with solder.

A special point to note about this circuit is the small diameter of holes punched through the base and their nearness to the edge. Most laminates should not be punched with holes smaller or closer to the edge than the thickness of the material. But on this tiny radio chassis made of copper clad phenolite, holes were punched as small as 0.040 in. and (in one case) only 3/64 in. from the edge.

There are more than 25 different methods of putting a conductive pattern on an insulating base. The most popular method uses a combination of laminating, printing, etching and electroplating.

Prepare an enlarged drawing

The first step is always the preparation of an enlarged circuit-pattern drawing, which is photographed and the negative held for later use. Laminated copper-clad plastic sheets are then cut in sizes to hold a practical, economical number of up to 50 circuits.

After the sheets have been cleaned, a light-sensitive photo-emulsion is flowed over, or sprayed onto, the surface. This photo emulsion is only sensitive to strong actinic light (such as a carbon arc) and so can be safely handled under normal lighting conditions. Then a contact print is made on the panel, using the negative made before. When a 45 second to six minute exposure is made in strong arc light, the circuit picture is transferred to the metal.

A chemical developer then dissolves the unexposed parts of the photo-emulsion and hardens the exposed parts. A well defined acid resistant pattern of the circuit is left and, after flushing, is ready for etching in Baume ferric chloride solution. Experience has shown that photo-engraving and offset printing are the two best methods and, of these two, photo-engraving is the more accurate. **(Continued on next page)**

Printed circuits *continued*

But for large runs where extremely fine circuit detail is not required, offset is better. Offset printing plates are made from the circuit pattern drawing by the same engraving methods. Then the circuit patterns are printed on the copper clad sheets in ink — an ink having high resistance to acid. Asphalt powder is fused to the printed pattern to fill any small pinholes and then etching (exactly the same type as for photo engraving) follows.

There is another process worth remembering. In the making of printed switches, commutators, and similar components, circuits are often plated with hard metal or solder to provide the necessary wearing, soldering and corrosion resistant properties.

The process used to print plated circuits is very like the processes already described. The circuit pattern is printed in reverse on the copper-clad panel using a plating-resist ink. The plating metal (silver, solder, hard nickel or rhodium) is then electroplated to the copper area not covered by the resist. After this, the resist is removed and the panel is ready for etching.

During the etch the plating acts as a resist and the circuit pattern formed by the plating is left intact. Only the area not covered by the plating is etched away.

Most circuits need through-connections between opposite sides of the circuit panel. Good through-connections can be made by plating holes that have been punched or drilled in the circuit panel. This is quite simple. The area around the hole is covered with an acid resistant and then a metallic (or carbon) film is applied to the hole to make it conductive. The panel is placed in an electroplating bath and the plating metal sticks to the conductive film to build up a complete through-connection.

These plated through-connections are reliable and cheap and they make dip soldering easy.

The Phenolite base material is a laminated plastic with copper foil bonded to one or both sides. The foil serves as the conductor, the laminated plastic as an insulating support. The electrical properties of the finished printed circuit depend on the combined properties of the laminate, the foil and the bonding agent.

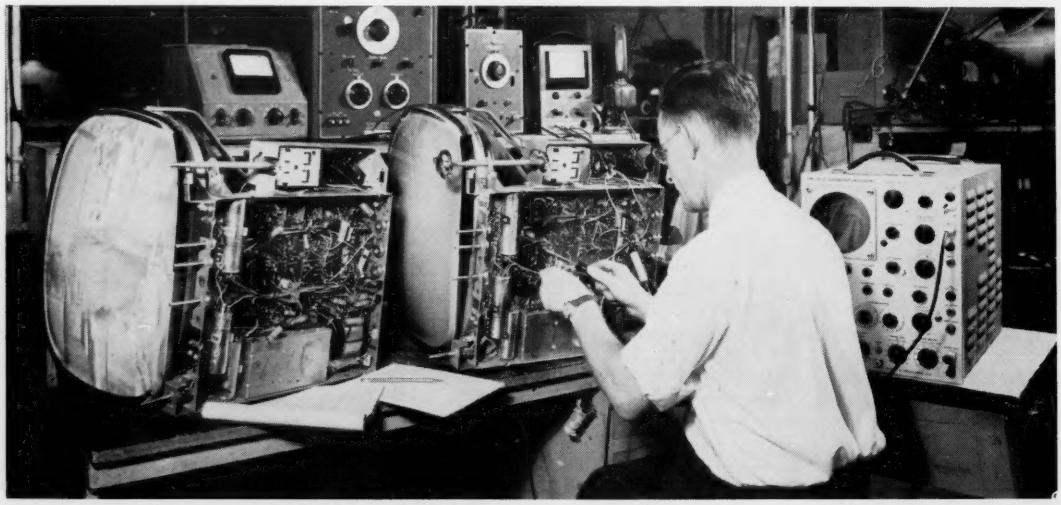
Layouts of just a short while ago take on an antique look when put against the printed circuit of today.

Phenolite laminated plastic plays a big part in the construction and function of the circuit. The grade and quality of the laminate must therefore be chosen to give low-loss insulating properties, mechanical strength, low moisture absorption, heat resistance, and ease of fabrication. In fact the completed circuit is only as good as its laminate.

The type usually used for printed circuits is Grade XXXP, selected because of its excellent insulation resistance, good hot punching qualities and low dielectric losses—even under severe humidity conditions. Grade XXXP effectively resists acids, alkalies, oils, solvents, heat and moisture, and provides a firm, light-weight backing that will remain stable under hard conditions. It is easily machined—punched, sawed, drilled, milled—with standard wood- and metal-working machinery.

Copper-Clad Phenolite is made in other grades to suit special needs. The choice of grade depends on the electrical requirements, the fabricating techniques and the physical properties desired. To assist the design engineer in selecting the right material, the available

A copper foil is ideal because of its purity, grain surface and cleanliness



Once a maze of components would have slowed the engineer seen here testing a printed circuit television set.

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Phenolite grades are listed by National Fibre Company.

The copper foil is made by a continuous electroplating process. The foil is ideal for printed circuit manufacture because of its purity, grain surface (on one side), cleanliness and availability in large widths.

The copper foil thicknesses in 98% of all present day printed circuits are .00135 in. (1 oz per sq ft) and .0027 in. (2 oz per sq ft). But foil is also made .0040 in. (3 oz per sq ft) and to 5 or 7 oz per sq ft on special order. Other foils are sometimes used for printed circuits too. Examples include brass for small resistance heaters, silver for wiping contact switches and aluminum for large production runs.

The material used to bond the copper foil to the laminated plastic should have the same high electrical properties as the base laminate. The first step in laminating is the cutting of the impregnated base material, the adhesive, and the copper foil into sheets of the desired size. Multiple sandwiches are than made of the base, adhesive, copper foil, and stainless steel press plates. The multiple sandwich is then placed in a hydraulic press and cured under heat and pressure. Slip-sheets are provided to protect the copper surface during trimming, packing and shipping. This laminating process gives copper-clad two of its most important physical properties — high resistance to heat and great peel strength.

Drawings must be clear

The printed circuit can only be as clear, clean and well defined as the circuit-pattern drawing from which it is made. To make the drawing and design of printed circuits easier, drawings are usually made four times the size of the finished circuits. The particular scale used will depend on the tolerances wanted in the finished job.

Drawing details should include the scale used and at least one critical dimension as a guide to proper reduction in the printing process. The lines and shapes of the circuit-pattern drawing should be drawn in black ink on stable, white board. This will give the right contrast for good reproduction and dimension stability. For very close tolerances, a drawing material with the stability of a plastic impregnated glass cloth is best.

The current-carrying capacity of printed wiring is quite high because of its large, exposed surface and heat dissipating characteristics. But, with a limited thickness, printed wiring must be made wide enough to carry the current and voltage with efficiency and safety.

For proper bonding through dip soldering, line widths of the foil and spacings of 1/16 in. to 1/8 in. are recommended. But a line width of 1/64 in. can be used if it is wanted.

The printing of components as integral part of the design is a logical development of printed circuit techniques. The difficulty with printed component development is the lack of precise control over capacities and performances.

Capacitors can be printed in parallel plate design for two-sided circuit patterns and interlocking finger design for one-sided and two-sided circuit patterns. Parallel plate capacitors can be made with a maximum capacitance range of 200 to 300 micro-micro-farads per sq in., and with a frequency range between 20 and 1,000 megacycles. However, high operating temperatures, frequency ranges, and restricted sizes limit the range of capacitors that can be made of copper-clad laminates.

Coils are printed in the form of a spiral and are usually limited to inductances of under 20 micro-henries. Printed resistors represent the largest application of printed component technique. Resistors can be printed with resistive ink in values of 50 ohms and up, and within tolerance ranges that meet JANR-11 electrical specifications. The ink employed is a graphite or metallic powder with a thermosetting resin binder. Filters and solvents are added to make sure of clear printing.

To get maximum control over the resistor value, resistors are sometimes printed a little below the desired value and then are adjusted by abrasion. Printed circuit techniques have a great future in the production of wiping switches. Some wiping switches can be printed at a cost much lower than by any other manufacturing method. The complexity and detailed nature of the switch does not contribute to the actual tooling and production costs of the switch. It costs no more to print a switch with 100 interconnecting, complicated elements than it does to print a switch with 50.

Flush circuit patterns are sometimes used for high speed and low torque wiping switches and commutators. The circuit pattern is printed and etched in the usual manner, and then pressed into the laminated plastic to make the copper-clad surface co-planar with the surface of the laminate.

A special grade of copper-clad Phenolite, Grade XXXP-219-C, is available for this process. The printed circuit is inserted between stainless steel plates, and then placed in a press padded with Kraft paper or cloth. A pressure of 250 psi is then applied for a period of five minutes at 350 deg F. The pressure is then increased to at least 1,500 psi and the temperature decreased to 300 deg F, and held for a period of 30 minutes. The circuit must then be allowed to cool in the press under full pressure.

To provide the necessary wear and corrosion resistance, switch patterns are usually plated with silver or hard nickel and rhodium. This plating, and the bond strength between the copper-clad laminate, give such switches a service life upwards of 10 million revolutions. The design and construction of printed switches is fixed by the current, voltage, speed, brush pressure and materials required by the application.

Copper-clad Phenolite laminated plastic can be made almost as easily and cheaply as laminated plastic without

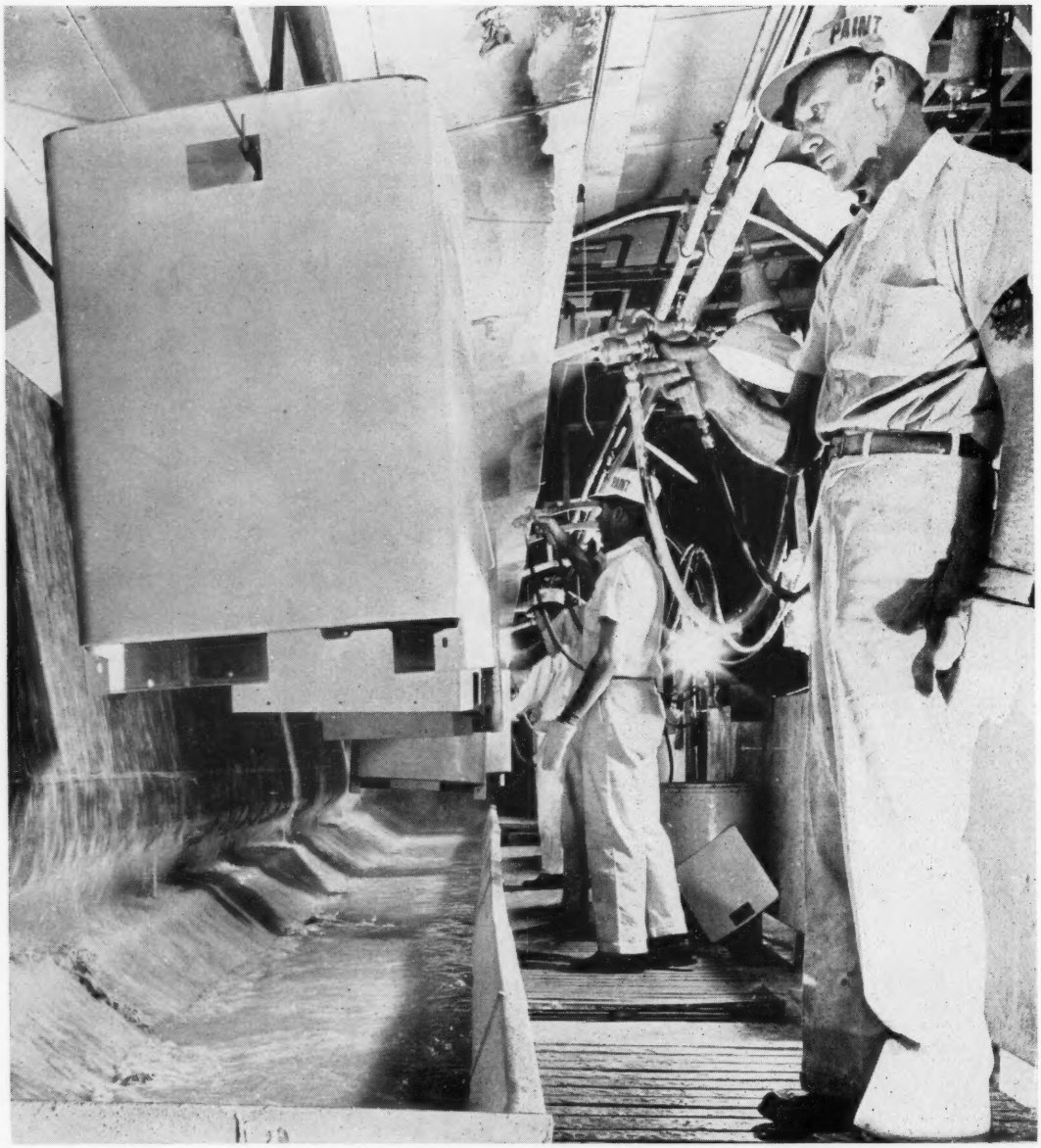
(Continued on page 58)

The special skills needed for checking circuits are now much reduced. This girl is testing continuity.

The New Epoxy Resins Are Strong, Flexible, Resistant, Adhesive

By Alexander Barrie
MANAGING EDITOR

Epoxy resins are winning the interest of world-wide industry. For there are very few protection problems they cannot easily overcome.



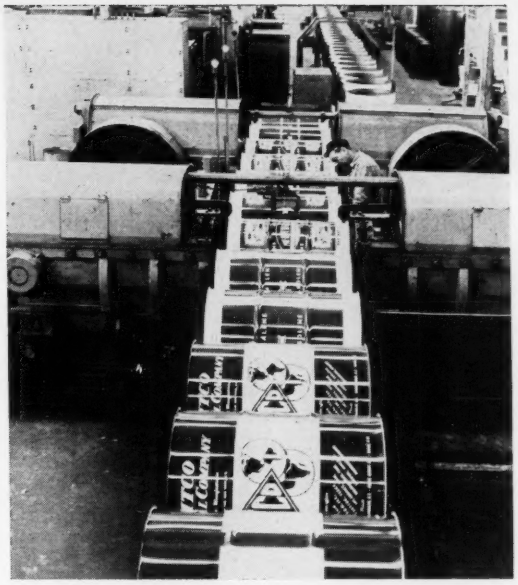
Epoxy resin finishes are ideal for home appliances. A production line epoxy spray job is shown in this picture.

WHAT DO YOU WANT from a protective coating? Toughness, flexibility, chemical resistance and adhesion? These qualities are all available through the new epoxy resins that are currently holding industry's interest throughout the world.

The epoxies are a new group of polymers coming entirely from petroleum sources and already in full production in Europe and the U. S.

Epoxy resins do not cross link (or cure) by the action of heat alone and so are usually combined with other materials for surface coating work. The behavior of the end coating depends a great deal, of course, on how it has been modified; but in all cases, the paint manufacturer and customer enjoy real benefits from the inborn character of the resins. They may be reacted with the fatty acids of drying oils to form epoxy-resin-esters which may then be further modified with melamine or urea resins in baking finishes. And they can be used with some reactive amines or polyamide resins to make coatings which cure at room temperature yet rival the performance of high quality baking enamels; or the nonesterified resin may be baked with urea or phenolic resins to make converted epoxy resin coatings which behave even better and take the good qualities of the resins to their highest point.

In a general way, the outstanding properties of epoxy resins may be related to their chemical structure.



Here drums are crimped in production after coating with epoxy. No harm will come to the tough finish.

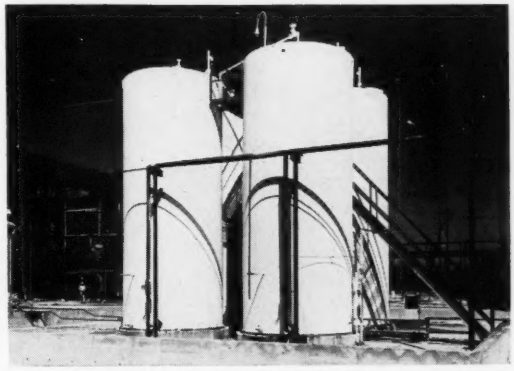
It is not surprising that the cured resins have a strong chemical resistance

They are condensation products of the reaction between bisphenol A and epichlorohydrin. Among the epoxies available to engineers are the well-known Epon resins.* In the Epon resins molecule the only chain bonds other than carbon to carbon, are ether linkages. Since these are among the most stable known to chemists, it is not surprising that the cured resin has strong chemical resistance. The functional groups in the molcule are widely spaced; so the cross links that form when the resin is cured are far enough apart to allow the unusual flexibility shown by the polymers. The polar nature of the molecule accounts for its outstanding adhesion to many materials.

Epon resin coatings can be divided broadly into three classes with different qualities and behavior caused by different modifying treatments: There are the popular Epon-resin-esters; the Epon amine system—which cures at room temperature; and the converted Epon resin coatings which give metal the best protection.

In Canada, high temperature baking ovens are less common than in the U. S., and so Epon resin ester coatings were the first to win popularity. The short oil esters (containing about 60% epoxy resin) are adaptable to the baking schedules of many manufacturers since they cure quickly at temperatures from 250-300 deg. F. Used with melamine or urea-formaldehyde resins they make excellent industrial primers. Their combination of superior adhesion, abrasion resistance and chemical resistance has given a higher standard of durability than conventional coatings could ever give. Better resistance to synthetic detergents has made them particularly useful for washing machines.

The unusual flexibility and rapid cure of epoxy resin esters have led to their use in collapsible tube coatings. Under repeated flexing the tube metal has been known to fail before the coating has cracked or lifted. This remarkable toughness has improved the quality of cap and closure finishes. The stock may be coated in the flat and then post-formed or crimped without damaging the film. Baking enamels based on short Epon resin esters are also suggested for metal cabinet finishes, hardware coatings, machinery finishes (where better oil resistance is an asset) and coatings for metal furniture and hospital equipment.



This Texas DDT plant is protected by an amine cured Epon resin which defies weather and chemical action.

Long oil esters (60% fatty acid) produce excellent air drying finishes that may be easily applied by brush or spray. They make tough, flexible floor varnishes that give unexcelled wearing qualities. Widely used in industrial maintenance paints, they give excellent protection to wood, metal or concrete structures. In food processing plants where frequent washdowns are necessary these coatings withstand the repeated use of caustic cleaners. This superior resistance has increased film life and greatly lengthened the period between recoats. Since they are not sensitive to alkali they may be applied directly to concrete, so saving the cost of a special primer. Strong solvents are not met with this type of finish since mild petroleum thinners

*Shell Chemical Corporation's registered trademark.

(Continued over page)

are used in their manufacture. So these coatings are popular with painting crews and operating employees.

Now look at the Epon resin-amine cured coatings. The main contribution of these is their ability to provide the properties of an oven-baked film in a coating that will cure at room temperature (60-70 deg. F.). The chemical resistance and toughness of these finishes is equal to all save the very best baking enamels—but they are as convenient to apply as most air-dry formulations.

Since this coating will "bake" (or cure) at low temperatures it always comes in two containers. One contains the base resin and pigment portion, the other the curing agent. These two components are quite stable until they are mixed together. Mixing is carried out shortly before the finish is to be used, then the coatings are applied by conventional methods; by varying the solvents used they may be adapted to spray, brush or roller coating techniques.

As maintenance paints in severe corrosion service these coatings have shown exceptional durability. They have excellent adhesion to both dry and green concrete as well as wood and metal and are good for coating practically all process areas. Paper mills, chemical plants, oil refineries and marine installations have solved difficult corrosion problems with this type of coating.

Although noted for their ability to cure fully at room temperature Epon resin-amine cured finishes may be force dried or baked in regular ovens to meet fast production schedules. They give long term protection for tank trucks in solvent and chemical service where corrosive spills cause quick failure of conventional finishes. They combine beauty and utility as the only coating in evaporator coolers. A single coat of an amine cured epoxy enamel has protected both the outside and inside of these air-conditioning units, even in extreme hard water areas. A major aircraft manufacturer has chosen a coating of this type to protect wing areas of transcontinental airliners from engine exhaust gases. The coating has shown no sign of failure or erosion after 1,000 flying hours and has been unaffected by the action of hydraulic fluids, fuels and lubricants. Other uses for the amine cured system include marine finishes, chemically resistant foil and paper coatings and linings for natural gas lines.

But the coatings which give the very best metal protection may be made from combinations of epoxy and phenolic resins. These coatings are astonishingly versatile. In a single mixture it is possible to combine hardness, flexibility and impact resistance with solvent and chemical resistance of the highest order. These finishes will give protection from caustic at any concentration, from mineral and organic acids, aliphatic and aromatic hydrocarbons, including aviation gasoline and jet fuel, from many chlorinated and oxygenated solvents as well as pure water and aqueous solutions. When properly baked they will withstand severe reverse impact tests and will pass a ⅛-in. conical mandrel bend test with no failure.

Epon resin-phenolic combinations require a temperature of 300-400 deg. F. for proper baking and where the coatings are used in chemical service it is much better to overbake them than to risk an undercured film. The finishes may be easily prepared in many colors, but whites have a grey look because

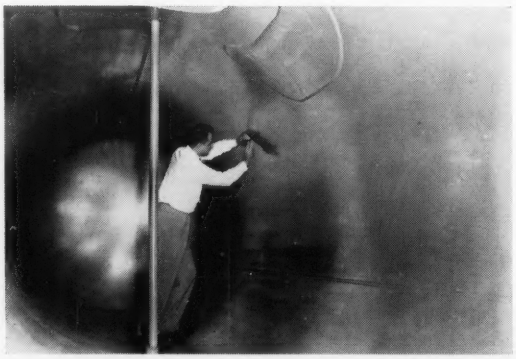
This DC 7's wings are Epon protected from blow-back.

of the phenolic resin content. Such coatings are now widely used as can linings, drum linings, coatings for process equipment and tank-car linings. They have enabled chemical manufacturers to replace wooden barrels with steel drums for world wide shipment of detergent concentrates; they have also made the steel drum a satisfactory package for many other materials which formerly required glass, wood or alloys.

Only marginally inferior to epoxy resin-phenolics in resistance properties are the urea-Epon resin combinations. These coatings have very good color and can be used as excellent whites and pastels. They find their widest use as metal finishes, both in clear and pigmented form. They may be applied with conventional spray or dipping equipment or by the newer flow-coating or electrostatic spraying techniques. Optimum baking temperatures are 350-400 deg. F. The exceptional resistance of these coatings to synthetic detergents has enabled washing machine manufacturers to improve quality and at the same time reduce finishing costs. Thinner coats of Epon resin-urea primers give better protection than heavier coats of conventional primers so that for any given volume the Epon resin finish adequately covers a larger area. Public acceptance of automatic appliances and the ever-increasing use of synthetic detergents are rapidly expanding the use of these coatings in Canada.

The Epon resin-urea system has greatly increased the durability of other metal products, such as lawn and beach furniture, metal awnings and laboratory equipment. In many cases the improved performance contributed by an epoxy resin-urea primer has been such that upgrading the top-coat was found unnecessary.

The Epon resins have provided paint chemists with the means of building better toughness, chemical resistance, and flexibility into a huge variety of surface coatings. These are the finishes of the future. ★



A newly epoxy-lined tank car has a thickness check.

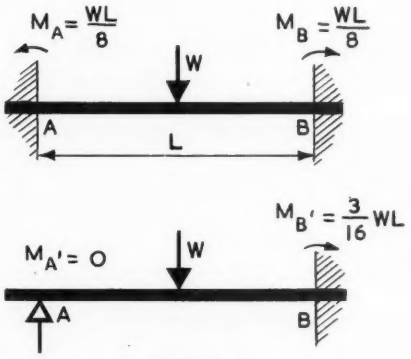
Solve Continuous Beams a Quick Way

By William Morse, P.Eng.
ENGINEERING EDITOR

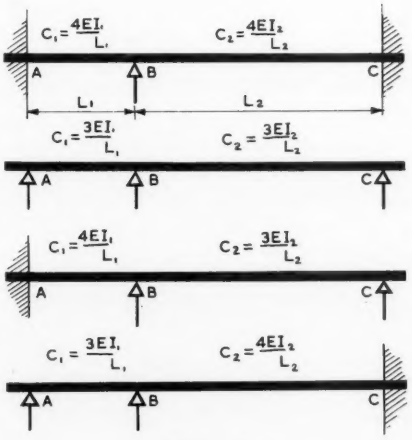
Begin by thinking of each span as a fixed beam, then follow through the Hardy Cross moment distribution method for continuous beam problems

THE HARDY CROSS MOMENT distribution method of solving continuous beam problems is a rapid, practical method. In it, each span is first looked upon as an independent fixed beam and the resulting end moments found.

These end moments are easy to find for a beam of constant I, because they depend only on the span and loading and so can usually be taken from standard cases. (For tapered beams this information can be got by the column analogy method, see DESIGN ENGINEERING, April.)



Picture 1



Picture 2

Any resulting out of balance at the supports is overcome by applying an equal and opposite releasing moment and distributing this between adjacent spans, with proper regard to their stiffness.

These two basic rules, relating to carry-over and stiffness, must be followed:—

For carry over:

Consider the fixed beam AB in Picture 1 of constant I, carrying a central load W.

Fixing moment at A: $M_A = \frac{WL}{8}$

Fixing moment at B: $M_B = \frac{WL}{8}$

Now let A be released so that it becomes a simple support, by applying at A a moment equal and opposite to M_A. This makes $M_A' = 0$, and $M_B' = 3/16\ WL$ as can easily be checked because it is the standard case of a propped cantilever.

In other words, the moment at B has been changed from $WL/8$ to $3WL/16$, that is, an increase of $WL/16$, which is half the releasing moment applied at A.

The rule for carry-over for a constant I beam, no matter what load it carries, is thus: **the carry-over moment to B when A is released is half the releasing moment at A. That is, the carry-over factor is a half.**

For stiffness

When considering the relative stiffness of two adjacent spans AB and BC of length L_1 and L_2 and moment of inertia I_1 and I_2 respectively, the four conditions shown in Picture 2 apply. A and C can both be fixed, both pinned or one pinned and the other fixed. For case (a) in which A and C are both fixed, the absolute stiffness of AB is

$$C_1 = \frac{4EI_1}{L_1} \text{ and of } BC,\ C_2 = \frac{4EI_2}{L_2}$$

If A and C are both pinned, the absolute stiffness of AB is

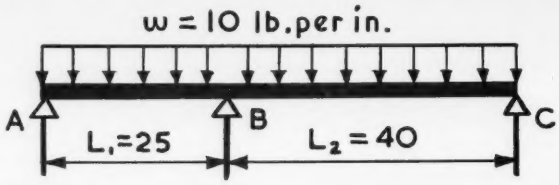
$$C_1 = \frac{3EI_1}{L_1} \text{ and of } BC,\ C_2 = \frac{3EI_2}{L_2}$$

In all cases, the stiffness ratio of $AB = \frac{C_1}{C_1 + C_2}$

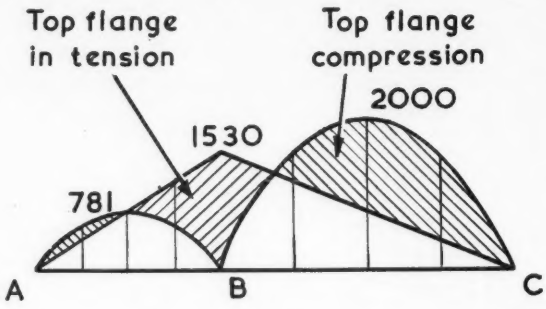
and the stiffness ratio of $BC = \frac{C_2}{C_1 + C_2}$

(Continued over page)

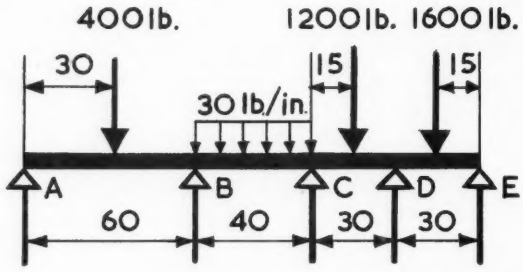
Picture 3



Picture 4



Picture 5



Look at this example:

To show how the method works, find the distribution of bending moment on the simple continuous beam of Picture 3. I is constant throughout.

Absolute stiffness of AB.

$$C_1 = \frac{4EI_1}{L_1} = \frac{4EI}{25} = .16EI$$

Absolute stiffness of BC.

$$C_2 = \frac{4EI_2}{L_2} = \frac{4EI}{40} = .10EI$$

$$C_1 + C_2 = .26EI$$

ITEM 1.

$$\text{Stiffness ratio of } AB = \frac{C_1}{C_1 + C_2} = \frac{.16}{.26} = .615$$

$$\text{Stiffness ratio of } BC = \frac{C_2}{C_1 + C_2} = \frac{.10}{.26} = \frac{.385}{1.000}$$

ITEM 2.

End moments on AB as an isolated fixed beam

$$= \pm\frac{WL_1^2}{12} = \pm\frac{10 \times 625}{12} = \pm 521 \text{ lb. } in.$$

Corresponding end moments on BC are ± 1333 lb.-in.

Since the beam is freely supported at A and C, the final moments there must be zero. Hence, release A and C in the Moment Distribution Table, line 3 by applying equal and opposite cancelling moments:

This gives carry-over moments—as arrowed—to each side of B. The net out-of-balance at B namely $-1999 + 781 = -1218$ lb. in., is divided numerically between AB and BC in proportion to their stiffness ratios .615 and .385, giving respectively $+749$ and $+469$ in line 5, Distribution. The final moments are obtained in line 6, from which it will be seen that there is now balance at B. The Bending Moment diagram is given in Picture 4.

		A	B	C
1	Stiffness ratio		.615 | .385	
2	Initial fixing moments	−521	+521 | −1333	+1333
3	Release A & C	+521→	+260 | −666	←−1333
4	Nett moments		+781 | −1999	
5	Distribution		+749 | +469	
6	Final moments	0	+1530 | −1530	0

member	I in^4	stiffness	stiffness ratio	
AB	60	$\frac{3}{4}\frac{4}{L} = 75 \times \frac{60}{60} = .75.$	$\frac{AB}{BC} = \frac{.75}{2.25} = .33$	$\frac{BC}{AB} = .67$
BC	60	$\frac{I}{L} = \frac{60}{40} = 1.5$	$\frac{BC}{CD} = \frac{1.5}{3.0} = .50$	$\frac{CD}{BC} = .50$
CD	45	$\frac{I}{L} = \frac{45}{30} = 1.5$	$\frac{CD}{DE} = \frac{1.5}{2.625} = .571$	$\frac{DE}{CD} = .429$
DE	45	$\frac{3}{4}\frac{I}{L} = .75 \times \frac{45}{30} = 1.125$		

Here is another example—a 4 span beam with I constant through every span

	A	B		C		D		E
Stiffness ratio		.33	.67	.50	.50	.571	.429	
Initial moments	−3000	+3000	−4000	+4000	−4500	+4500	−6000	+6000
Release A & E	+3000→	+1500					−3000	←−6000
		+4500	−4000	+4000	−4500	+4500	−9000	
Release B		− 167	− 334→	− 167				
		+4333	−4334	+3833	−4500	+4500	−9000	
Release D					+1285	←+2570	+1930	
				+3833	−3215	+7070	−7070	
Release C			− 154	←− 309	− 309→	− 154		
		+4333	−4488	+3524	−3524	+6916	−7070	
Release B		+ 51	+ 102→	+ 51				
		+4384	−4384	+3575	−3524	+6916	−7070	
Release D					+ 44	←+ 88	+ 66	
				+3575	−3480	+7004	−7004	
Release C			− 24	←− 48	− 48→	− 24		
		+4384	−4408	+3527	−3528	+6980	−7004	
Release B		+ 8	+ 16→	+ 8				
		+4392	−4392	+3535	−3528			
Release D					+ 7	←+ 14	+ 10	
				+3535	−3521	+6994	−6994	
Release C			− 2	←−3.5	−3.5 →	− 2		
Final moments	0	+4392	−4394	+3531	−3535	+6992	−6994	0

Note that A and E are released first and kept released throughout.

Wheel slip is an old enemy. Now the TCU device (tractor shown has one) has almost entirely overcome it.

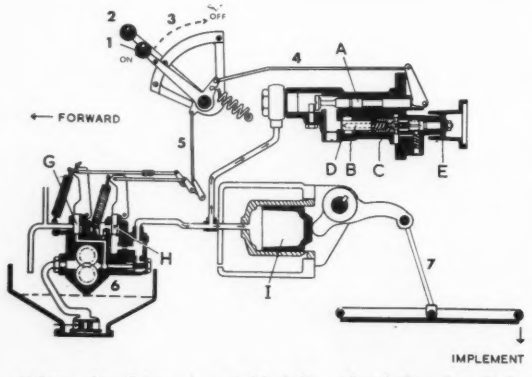
Britain Beats the Wheel Slip Problem

Granville Wilson
U. K. CORRESPONDENT

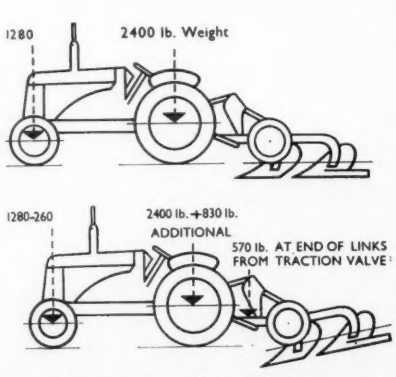
A small adjustable valve built into the hydraulic system of a tractor can shift part of a towed implement's weight onto the rear wheels when they start to spin

A BRITISH engineering company believes it has solved the problem of tractor wheel slip in soft ground. David Brown Tractor (Engineering) Ltd., with an associated company in Canada, has designed a traction control unit (known as TCU) which can quickly transfer weight from a towed implement to the rear wheels of the tractor. With the same breath, the company has come up with a new two or three furrow hydraulically mounted disc plow which works in all types of soil from loose sand to the stiffest clay. It is light in weight but a hard digger.

The traction control unit, which is fully protected in all countries, is a simple yet scientific device for



When the driver is troubled by wheel slip, he flicks the lever (2), weight is transferred and slip quickly stops.



Diagrammatically, this is what happens. Note that furrow depth does not change.

use with David Brown wheeled tractors and mounted implements. Its primary purpose is to combat wheel-slip without the aid of wheel weights, ballast, wheel strakes, oversize tires and other methods.

This is done by transferring at will a certain proportion of the implement weight to the rear wheels of the tractor. With TCU the downward pressure on the rear wheels of the tractor can be increased by almost 35 per cent.

The tractor may be looked on as a beam carrying an additional overhung load of 570 lbs. This takes load off the front wheels, moves the CG aft and increases the load on the rear wheels.

The device is controlled by a small, adjustable valve built into the hydraulic system of the tractor, which can be set manually by a traction control handle (E). This is fitted to the front face of the rear axle housing within easy reach of the driver.

After pre-setting this valve at any one of 12 positions, traction control is applied by means of a traction control lever, which is coupled to the normal power lift lever. With a little practice, an experienced tractor driver can choose the amount of weight transfer required. When the less skilful operator encounters wheel slip, he can, by flicking over the traction control lever, immediately get out of trouble and resume working.

There are several advantages. The additional pressure on the rear wheels, with its proportional increase in drawbar pull, is applied by a flick of the wrist only when required. It involves no waste of fuel and power in hauling unnecessary weight, which tends to pack the soil and, in the case of water ballast, causes rapid tire wear.

It reduces the farmer's initial costs by doing away with the need for oversize tires, except in extreme conditions. In addition, tire replacement costs are less.

And apart from cost considerations, TCU cuts out the time and labor involved in fitting and removing wheel weights, strakes or ballast.

A most important feature of TCU is that the selective transfer of weight from the implement to the tractor wheels involves no loss of control over the working depth of the implement. This vital control is maintained under all conditions by a depth control wheel.

The TCU will be included in the standard specifications of all David Brown tractors fitted with hydraulic lift. The new unit is incorporated in all such tractors supplied in 1955.

With the traction control lever (1) fitted alongside the normal power lift quadrant (3). (See picture) in the forward or ON position, the connecting linkage (4) opens the traction control shut-off valve (A) to the pressure line of the hydraulic system from the pump (6). The same action, by means of linkage (5), puts the hydraulic lift lever (2) in the lift position so that both the by-pass valve (G) and main pressure control valve (H) at the pump are closed.

Three valves are included in the traction control valve assembly: There is the poppet type shut-off valve (A); the flow control valve (B) that allows a build-up of pressure in the system but controls the flow to exhaust so that the capacity of the system is constant and no displacement of the piston (I) are relative movement at the linkage takes place; and there is a manually adjustable ball type pressure control valve (C) which acts as a bleed to the flow control valve (B). Valve (C) receives a restricted supply of fluid (through passages in the flow control valve B) and controls the system over a wide range of pressures.

When the shut-off valve (A) is opened, the control valve (B) is in the closed position and would normally control the pressure in the system. The control valve, however, is made inoperative as a pressure control valve by drilling through the valve which gives equal pressure on the front and rear valve faces. This drilling permits a restricted pressure to be developed and to be effective on the pressure control valve (C). The leakage of fluid past (C) slightly reduces the pressure acting on the rear face of (B) which moves this valve at the port (D).

When (B) has moved far enough to equalize the pressure on the front and rear faces of the valve (caused by a reduction in pressure on the front face following an increase in exhaust aperture opening) the flow control valve (B) remains substantially static and the pressure in the system is constant.

In this manner, pressure is applied to the hydraulic ram piston (I) without any relative movement taking place and a static lifting force is applied at the lift linkage (7).

By Shifting Loads Through the 'TCU'

The pressure built up is not enough to lift the implement, but the effective weight of the implement is considerably reduced and a corresponding additional load is imposed on the rear wheels of the tractor. Extra adhesion of the driving wheels comes without relative movement in the hydraulic system and the depth and width settings of the plow remain constant.

Variation of the force countering the weight of the implement is obtained by varying the setting of the control valve (C). When its spring is under maximum compression, a maximum lift equal to about 35% of the implement weight is obtained and an equivalent balancing downward force is exerted at the rear axle of the towing tractor as a result.

The new disc plow is interesting

David Brown's new disc plow also is interesting from the weight point of view. Although it will bite into hard sun-baked surfaces and rides undamaged over jagged rocks, it weighs only 830 lbs and so can be hauled by quite light tractors. This, of course, greatly broadens its appeal.

Its main frame is tri-angular and the disc plowing assemblies are carried on a heavy-gauge tube main member. There are nine settings for the discs to cover all plowing conditions. A flanged spring-loaded thrust wheel (see picture) bolted to the rear disc assembly, bites into the furrow wall and counters the side thrust of the discs.

This new plow can be hooked up through the TCU to give a weight transfer to the rear wheels of the tractor without difficulty. In announcing these two new developments David Brown Tractor (Engineering) Ltd., believe they have solved some old problems with some modern engineering answers. ★

What will the modern MoS_2 graphite-like lubricant do for you?

By Frank O. Farey, B.A.

Without new, improved lubricants there will be little progress with machines; here is a new one with rare qualities.

MOLYBDENUM DISULPHIDE (MoS_2) is a mineral which looks like graphite but is softer and about twice as heavy.*

It has come quickly forward during the last five years as a lubricant which can handle some very tough problems for design engineers. Its very complete purification and small particle size explain this quick progress and promise many more uses for it in the future.

Molybdenum disulphide comes mostly from Colorado, where the ore concentration averages about ½ of 1%. But it is also recovered as a by-product from copper ores. Sometimes, too, small quantities of a nodular form are found.

Since the sulphur in it is chemically combined, molybdenum disulphide does not react on metals like free sulphur, and is chemically stable. It resists most acids except aqua regia (a mixture of one part nitric to three of hydrochloric acid), strong boiling hydrochloric acid, fluorine and chlorine. It decomposes at room temperatures in pure oxygen.

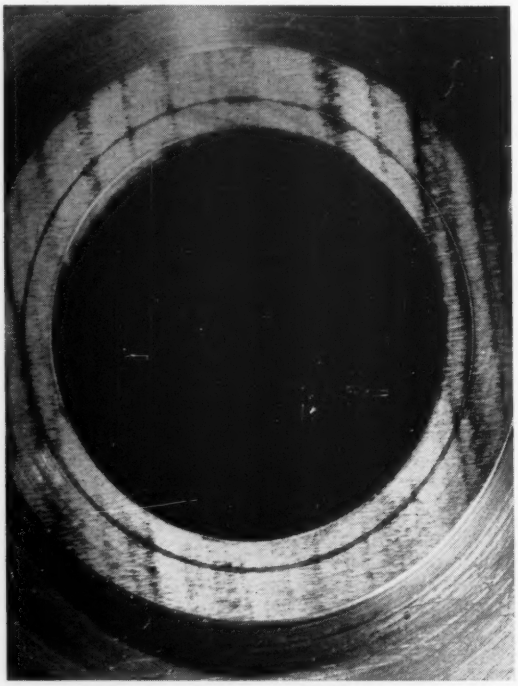
Molybdenum disulphide will not dissolve in hot or cold water, or in solvents, or in petroleum or synthetic lubricants. It is thermally stable and retains its lubricating qualities from —300 deg F to 750 deg F in air and this figure soars to over 2,000 deg F in the absence of air. So it is a useful lubricant not only for low temperature conditions (in studs and other threaded connections where the freezing is a problem after long periods of installation) but for relatively high temperatures such as bake ovens, chain lubrication and furnace equipment.

Molybdenum disulphide does not cause corrosion, but on the other hand the dry powder does not prevent it. Under damp or wet conditions it is better to use an oil vehicle, although a bonded coating gives material protection.

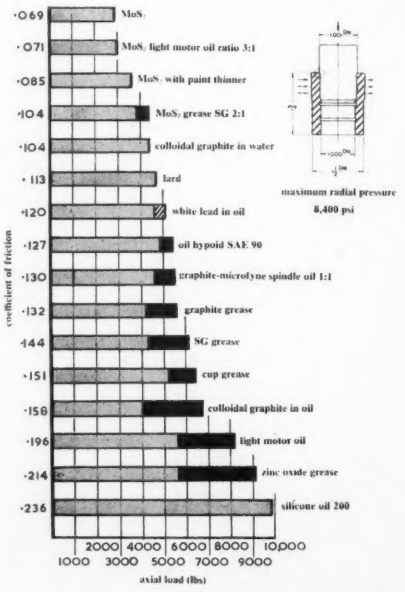
The molecular structure is most suitable for lubrication. Its behavior can, in fact, be compared with that of a slice of bread, buttered on both sides. The bread represents the molybdenum atoms and the butter the sulphur atoms. Since the shear strength of butter is weak, stacks of vertical layers will slide laterally on one another.

The atomic structure is revealing. The outer sulphur

*Its specific gravity is 5.0 approximately.



An MoS_2 lubricated press-fit which shows that entire area does not share load. The dark areas mean wear.


coefficient of friction
·069 MoS₂
·071 MoS₂ light motor oil ratio 3:1
·085 MoS₂ with paint thinner
·104 MoS₂ grease SG 2:1
·104 colloidal graphite in water
·113 lard
·120 white lead in oil
·127 oil hypoid SAE 90
·130 graphite-microfyne spindle oil 1:1
·132 graphite grease
·144 SG grease
·151 cup grease
·158 colloidal graphite in oil
·196 light motor oil
·214 zinc oxide grease
·236 silicone oil 200
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
axial load (lbs)
maximum radial pressure
8,400 psi

This chart gives performance rating for various lubricants on a press-fit test.

atoms adhere strongly to metal surfaces, and it is assumed that the strong atomic bonds between the sulphur and metal account for this. The other laminae slip easily because of the weakness of the sulphur-to-sulphur bond. One theory which may very well be right, supposes that this weakness is due to the relatively large distance between the sulphur atoms.

As a high pressure lubricant, molybdenum disulphide appears to be unequalled. It resists pressures far beyond the yield point of any metal.

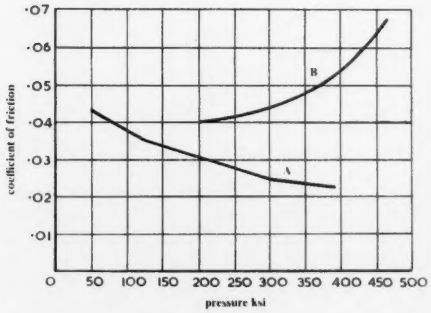
A curve performance (see A) shows tests at a speed of ½ rpm on hardened steel mating surfaces of small diameter lapped to about 2 rms micro inches. The lowest values are due to the density of the molybdenum disulphide on the surface, and are striking when compared with sliding-on-ice for which, even under the most favorable conditions, a value of 0.03 would be expected, as compared with 0.03 and less for molybdenum disulphide at pressures in excess of 200 ksi.

A second curve (see B) shows results of 16 successive wire drawing tests on carbon steel using molybdenum disulphide powder on lime-coated wire.

The upward trend of Curve B may be explained by the fact that the powder was in the draw box to be picked up by the wire. The surface roughness of the lime coating on the wire allowed liberal pickup of molybdenum disulphide in the first draw, and less was picked up in successive draws as the wire became smoother.

A graphic comparison of the coefficient of friction of various types of lubricant used in press-on fittings is shown here. Data was obtained by measuring the load required to force a 1.001-in. pin into a 1.000-in. bushing, resulting in 8,400 psi calculated radial bearing pressure. Black areas represent a load-range in which chatter was observed. The area shaded for white lead in oil represents the range in which chatter was found in some, but not all, tests.

In this series of tests, molybdenum disulphide, either dry or in combination with other materials, gave the lowest coefficient. On clean surfaces either the dry powder or a combined powder with the lighter petroleum oils, helped the molybdenum disulphide to adhere to the metallic surfaces and give a lower coefficient of friction than the heavier oils. Unless the molybdenum disulphide has first been rubbed on by hand, or burnished on to the surface, or applied as a bonded coating, the heavier oils seem to lessen or prevent adhesion.



Performance curves, at ½ rpm on hard steel (A) and (B) for carbon steel drawing test.

Like a slice of bread buttered both sides

MoS_2 is the bread, sulphur is the butter.

Many engineering and field reports have been issued by users of molybdenum disulphide. While the most remarkable results have been noticed under extreme pressure and temperature conditions where other lubricants have failed, there is ample evidence that when properly refined and properly applied, it will increase the life of any moving part of machinery and, in many instances, save power and labor costs.

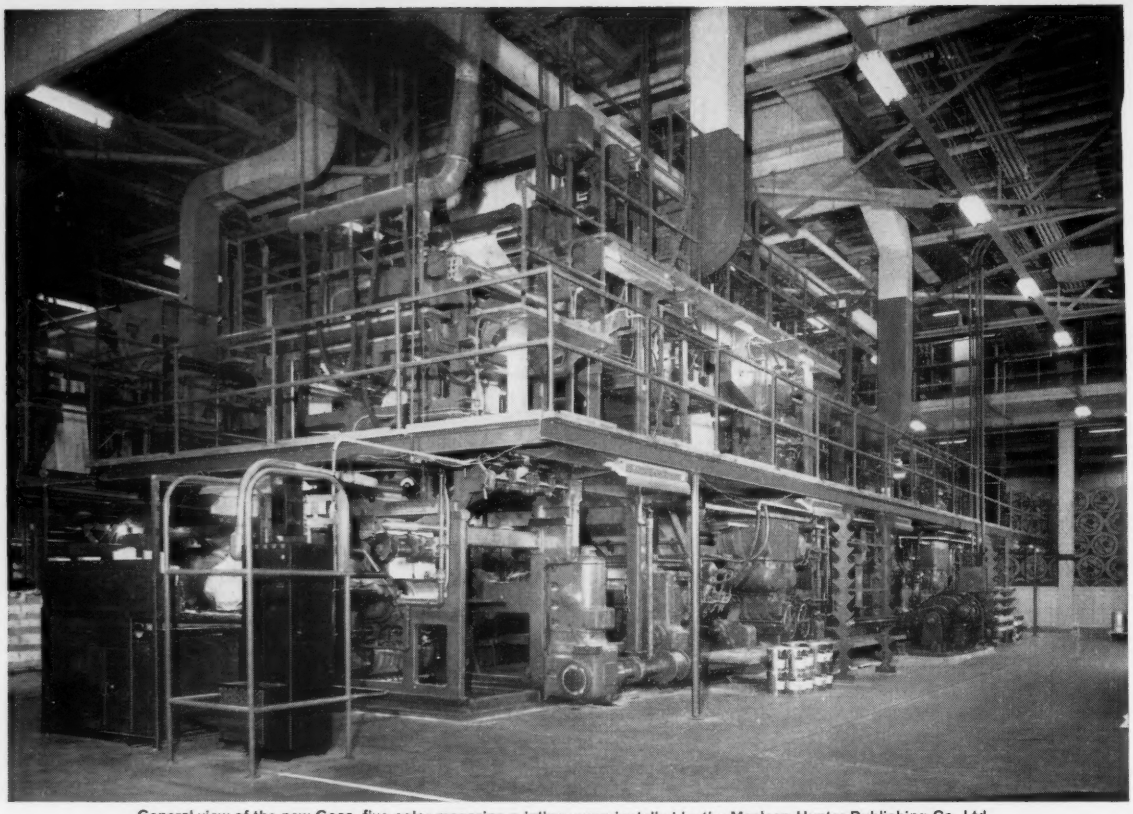
A striking example from one of the large commercial airlines showed that where splines previously had to be replaced every 400 flying hours, by using molybdenum disulphide most of them last for 1,200 flying hours and longer. In this case the powder was mixed with their regular spline grease to prevent moisture contamination. Although the machines sometimes came in quite dry, the molybdenum disulphide was still active as a lubricant.

While the field of economic uses seems to be almost unlimited some are of special importance: Severe cold forming such as shell nosing and heading operations, wire drawing, metal cutting, cams, toggle joints, gears, threaded connections, power screws, press-on fittings, deep drawing of sheet metals, are among them. This lubricant also has many uses to prevent or retard fretting corrosion, galling and seizing.

For temperature conditions it is used on threaded connections, sliding parts of internal combustion engines, steam and gas turbines, aircraft, plastic molding presses, jet engines, refrigeration machinery, military equipment, and oven chains. Molybdenum disulphide is also a great help in dusty atmospheres or immersed in hot or cold water, and for lead screws or sliding surfaces of plastic, stone, and much machinery in woodworking, cement, chemical and transportation equipment.

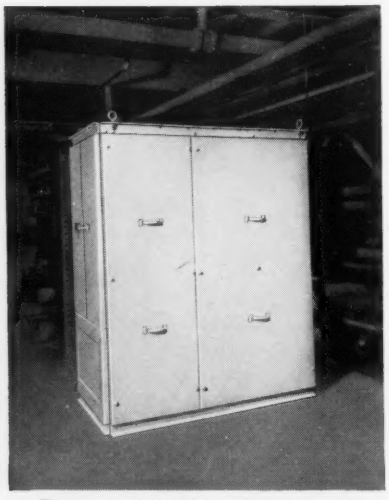
Against fretting corrosion, molybdenum disulphide has been successful in very obstinate cases of spline shafts. A grease form is generally used but bonded coatings show great promise. High starting friction is greatly reduced on heavy equipment as well as fine tools, measuring machines, and instruments where close tolerance means seizing problems. Successful results have been had with rubber on metal used with natural or synthetic "O" rings, packings, shaft seals in hydraulic equipment, cylinders, valves and pumps.

Molybdenum disulphide is good for a lifetime of intermittent use in relays, cameras, washing machines and floor polishers. On electrical contacts, life has been greatly increased in a number of cases of both power and electronic switches. Both the powder and a grease combination have been used. New uses will continue to come along for this modern lubricant. It is worth watching. ★

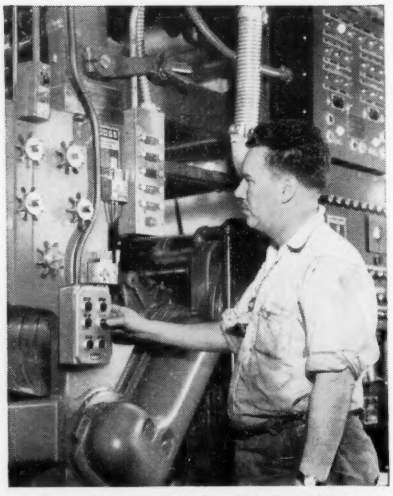


General view of the new Goss, five-color magazine printing press installed by the Maclean-Hunter Publishing Co. Ltd., Toronto. This 215-ton giant press is powered by a G-E 200 HP AC double motor wound-rotor Printing Press Drive.

Maclean-Hunter again selects G-E

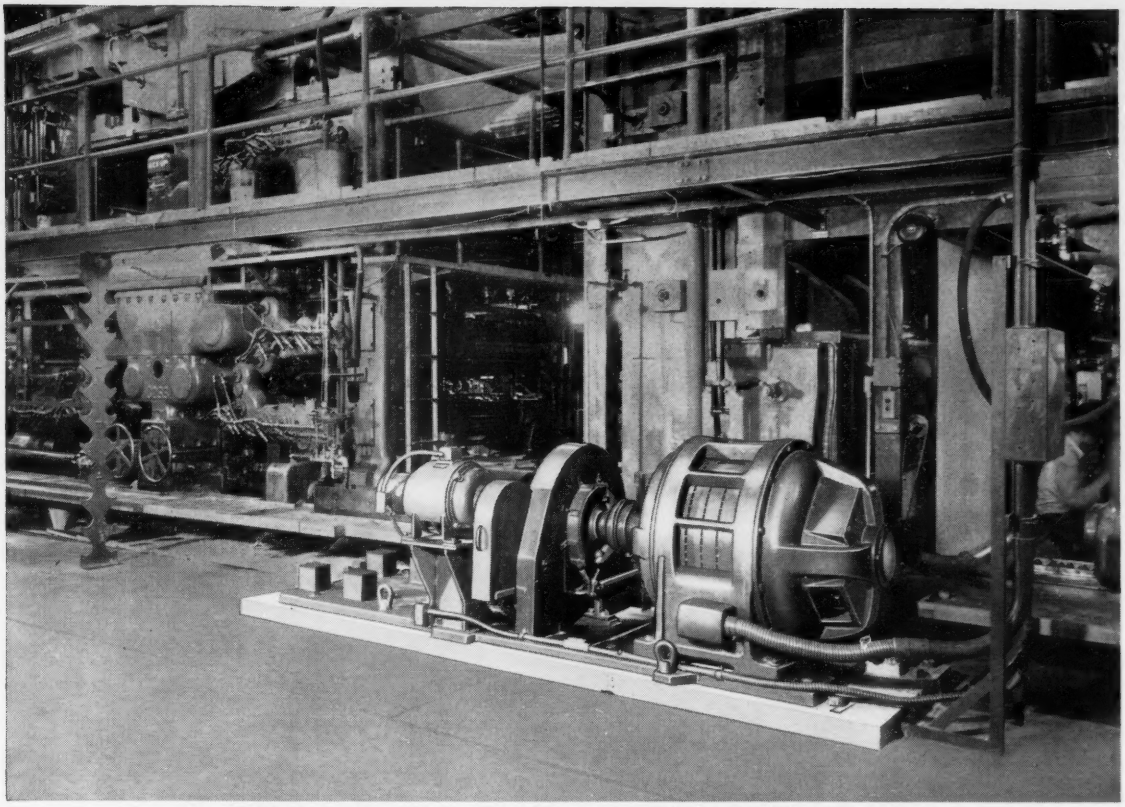


The main control cubicle and panel—mounting the contactors, relays and resistors for controlling the Press Drive.



One of the main control push-button stations for stopping, starting and jogging the Press Drive.

CANADIAN GENERAL ELECTRIC COMPANY LIMITED



This G-E 200 HP AC Double Motor Press Drive furnishes power for the new Maclean-Hunter five-color Goss magazine press. Provision has been made for the future mounting of a booster motor, if required.

Drive for new press

Canada's largest five-color magazine printing press, an $800,000 Goss weighing 215 tons, was recently installed by Maclean-Hunter Publishing Co. Ltd., Toronto. The third such machine to be installed by this company, they are all equipped with G-E Drives.

The new Goss, one-third faster than the previous machines, is driven by a G-E 200 HP AC double motor wound-rotor Printing Press Drive. Designed for minimum space requirements and low cost installation, the G-E Drive includes a 10 HP starting and threading motor, gearing, overrunning clutch and Thrustor* operated brake—assembled as a compact 4-bearing horizontal drive.

At top speed this new press will handle up to 19,600 forty-page magazine sections in five colors per hour . . . the equivalent of 3,920,000 single pages in one color. At this rate of production the web runs at a speed of 1,200 feet per minute.

This is another case where customer satisfaction with C-G-E equipment has brought repeat orders. For assistance in choosing and installing similar intricate electrical equipment call your nearest C-G-E Office or write to: Apparatus Division, Canadian General Electric Co. Ltd., 212 King St. W., Toronto.

**Reg'd. Trade Mark of General Electric Company.*

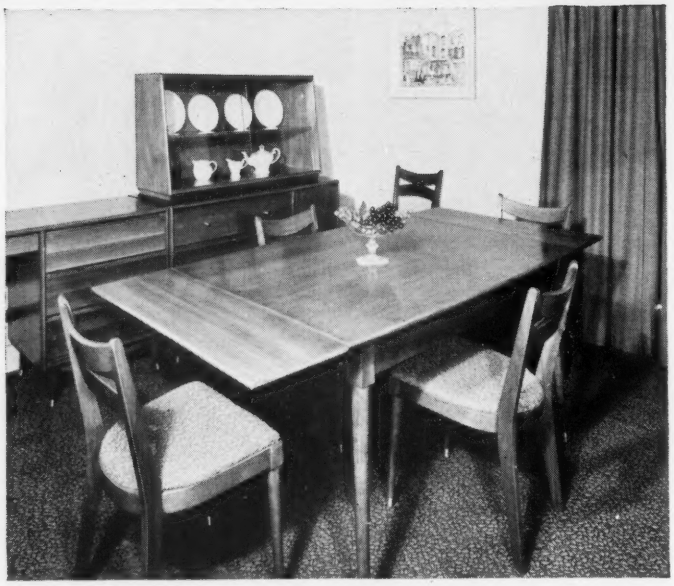
Another G-E Push Button Station controlling the color ink pumps on the Goss press.

GENERAL ELECTRIC
EQUIPMENT

AAD-65201

HEAD OFFICE: TORONTO—SALES OFFICES COAST TO COAST

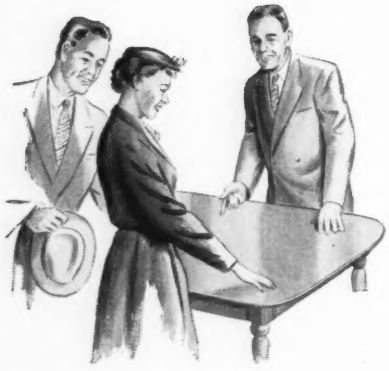
Vilas wanted a better furniture finish



The Vilas Furniture Company of Cowansville, Que., has a Canada-wide reputation as makers of distinctive furniture.

Always seeking improvements in products and finishing methods, Vilas turned to C-I-L technicians for a finish that would give better service than the lacquers and varnishes known to date.

-they found it in CILUX



RUBBING AND POLISHING VARNISH

Working closely with the Vilas organization, the C-I-L Paint and Varnish Research and Development Laboratory perfected a new finishing system incorporating CILUX Rubbing and Polishing Varnish. The result is an amazingly durable alkyd finish now advertised by Vilas as "Vila-Seal".

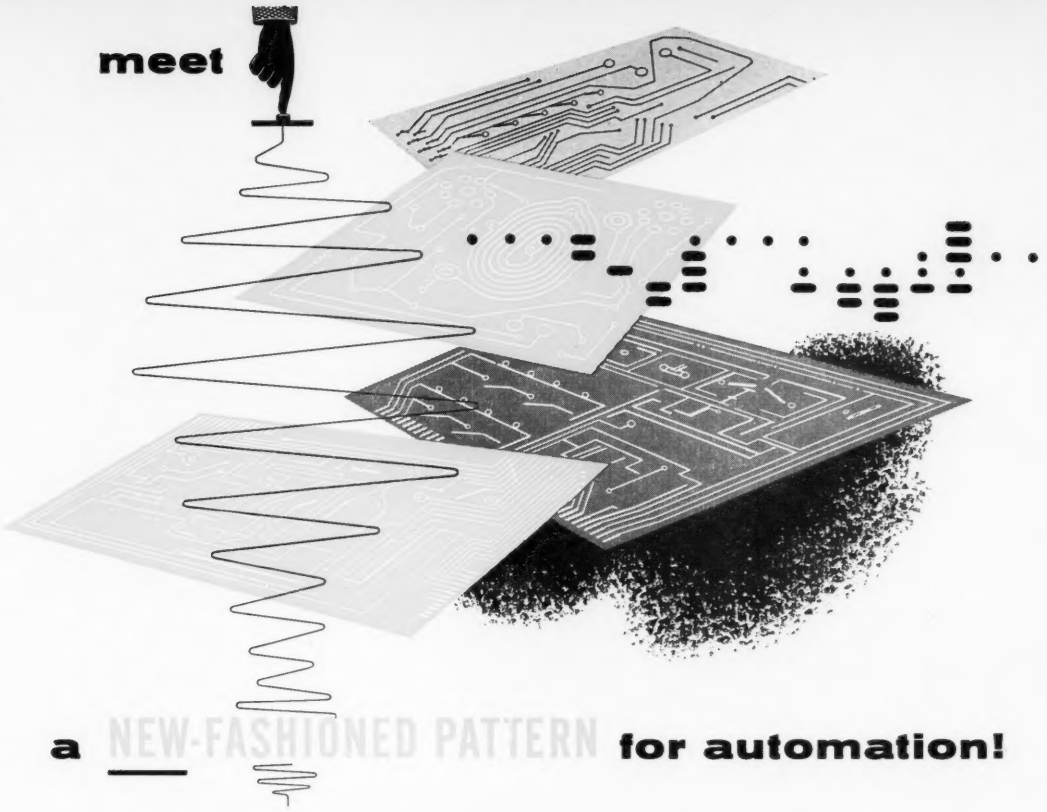
CILUX Rubbing and Polishing Varnish makes furniture highly resistant to almost every kind of household hazard, such as boiling water, alcohol, nail polish, perfumes, scuffing and abrasion.

* * *

For expert advice on industrial finishing problems, whether they involve a specific product or operation, or a complete production-line finishing system for wood or metal, call or write your nearest C-I-L Paint and Varnish Division District Office. Halifax, Montreal, Toronto, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver.

A FINISH FOR EVERY PURPOSE

C-I-L Industrial Finishes
SERVING CANADIANS THROUGH CHEMISTRY

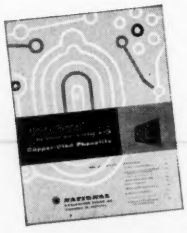


Automation is a sought-for goal today—but, for the electrical and electronic manufacturer, hand wiring and assembly are the stumbling blocks in its achievement. But now a bright entrant in the field, *printed circuitry*, overcomes this obstacle—and provides other equally great gains in addition!

Complicated manual wiring is replaced by a pattern of conductors, coils, resistors, and other components "printed" on a sheet of laminated plastic. Low in cost, uniform in performance, and free of wiring "bugs," such assemblies are speedily mass-produced. Labor costs are drastically cut two ways—far fewer personnel are needed, and lesser-skilled workers can easily assemble (and service) complex devices with less chance of error. Since exact wiring duplication is achieved, inspection is greatly simplified. Assemblies grow small in size, overhead is reduced, less floor space is needed . . . the whole problem takes a big "easy-does-it" step toward complete automation.

National Vulcanized Fibre Co. is a pace-setter in the development of foil-clad laminates —the basic materials for most printed circuitry. Copper-Clad Phenolite—by National—is recognized as the standard by fabricators everywhere. For Phenolite is a high-quality base laminate that can be *engineered* to fit *your* conditions. It has the high insulation resistance, low electrical loss, and low moisture absorption required in the *right* base material for printed circuits. It is light in weight, easily punched and worked, and withstands effects of the various circuit-printing processes.

No matter which method you use to produce printed circuits, Phenolite clad laminates are the ideal base materials. Whether clad with metal foils, or non-metallic materials (such as rubber, vulcanized fibre, etc.) there is a Phenolite laminate for *your* particular job.



HERE'S HELP FOR YOU—*our new, fact-filled, 12-page bulletin entitled "Mechanize Your Wiring With Copper-Clad Phenolite." Contains full information and application data on Copper-Clad Phenolite and other metal and non-metal clads. Write for it today! Address Dept. D.E.-6*

PHENOLITE Laminated PLASTIC

Also manufacturers of Vulcanized Fibre, Vul-Cot Waste Baskets, Peerless Insulation, Materials Handling Equipment and Textile Bobbins

NATIONAL

FIBRE COMPANY OF CANADA, LTD.

ATLANTIC & HANNA AVES., TORONTO • 1411 CRESCENT ST., MONTREAL

Patents

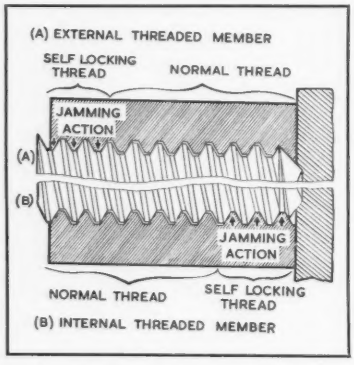
Some new ideas win protection in Canada

THE ROTO-SHAVER INCORPORATED, of New York, has obtained a Canadian patent on its rotary type of electrical shaver. This shaver, invented by George H. Robertson of Bellerose, New York, has a thin perforated shear plate that is placed against the skin so that the whiskers extend through the holes, and a rapidly rotating blade which "wipes" the inside of the shear plate when rotated. The blade is arranged so that the centrifugal force caused by rotation keeps the blade tightly against the inside of the shear plate for a close shave.

The patent issued on April 12, 1955 under No. 511,880.

• • •

A SELF-LOCKING thread for screws, bolts and nuts that is easily made without special tooling or processing is described



in Canadian Patent No. 510,258, which issued February 22, 1955. Invented by X. Raymond Dodge, of Hinsdale, Illinois, and Calvin O. Brown, Emburst, Illinois, this self-locking thread also has the advantage that it can be mated repeatedly with standard threads without damaging or deforming them.

The idea of the invention is shown above; it involves increasing or decreasing the "lead" relative to the normal lead of part of the thread, and also increasing or decreasing (depending on whether the thread is female or male) the pitch and the major and minor diameters. This provides an interference fit between some of the threads of the mated members.

The invention may be used to produce a liquid-tight seal by changing the minor diameter so as to provide an interference fit at this point.

• • •

STUDS FOR ELECTRIC arc welding to steel plates are claimed in Canadian Patent No. 511,783, which issued on April 12 to Crompton Parkinson, Ltd., of Yorkshire, England. The novel feature of the studs is the metallization of the welding and with a metal—aluminum, for instance—that has a higher electrical conductivity than the steel surface of the stud.

Inventor: Harold Martin of Chatham, Kent.

• • •

WIRE SAWS for sawing hard materials like stone and coal tend to wear out quickly and lose their ability to carry abrasive. Now a wire saw strand which is said to increase abrasive-carrying capacity is claimed in Canadian Patent No. 511,319 of March 29, 1955. The wire saw described has a special abrasive-carrying wire at the periphery of the strand; this wire is harder than the base wire, and has a relatively greater twist to project it to the periphery of the strand where it will take the most wear.

The inventor is Pierre de Vitry d'Avaucourt of Bainbridge, Pennsylvania.

• • •

A BEARING HANGER which is designed to give unusually flexible support for a rotatable shaft was patented in Canada on April 12 by Thompson Products, Inc., of Cleveland: No. 511,903. A universally mounted bearing is supported on frames that have resilient mountings, allowing the shaft to tilt freely and also to shift in a lengthwise direction.

The inventors named in the patent are Albert W. Gair, of Fraser, Michigan, and Edward J. Herbenar, of Detroit.

• • •

PATENT NUMBER 511,056 covers a method of using sound waves to agglomerate aerosols by increasing the speed and therefore the collision expectancy of the particles. They stick together until they are large enough to fall from gravity pull.

The patent was issued to the Ultrasonic Corporation at Cambridge (Mass.).

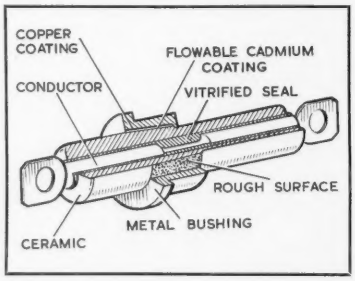
• • •

CANADIAN PATENT No. 510,363 (February 22) claims a ceramic seal for electric conductors which is said to solve the problem of fluid leakage when mounting a glazed ceramic insulator in a metal container.

Inventors George W. Shoobert and Denis J. Blight, London, England, provide a tapered roughened band on the ceramic body of the insulator as shown above. A metal bushing fits the tapered portion and is used to connect the insulator with the metal wall. To provide a fluid-tight seal between the bushing and the insulator, the inner surface of the bushing is electroplated with a metal which will flow into the roughened portion of the insulator under reasonable pressure.

The insulator can be roughened by sand blasting after glazing, or the tapered part may be left unglazed.

The bushing may be coated with



layers of different metals, the outer metal being capable of flowing under pressure: an outer layer of cadmium over a base layer of copper is said to be a good combination.

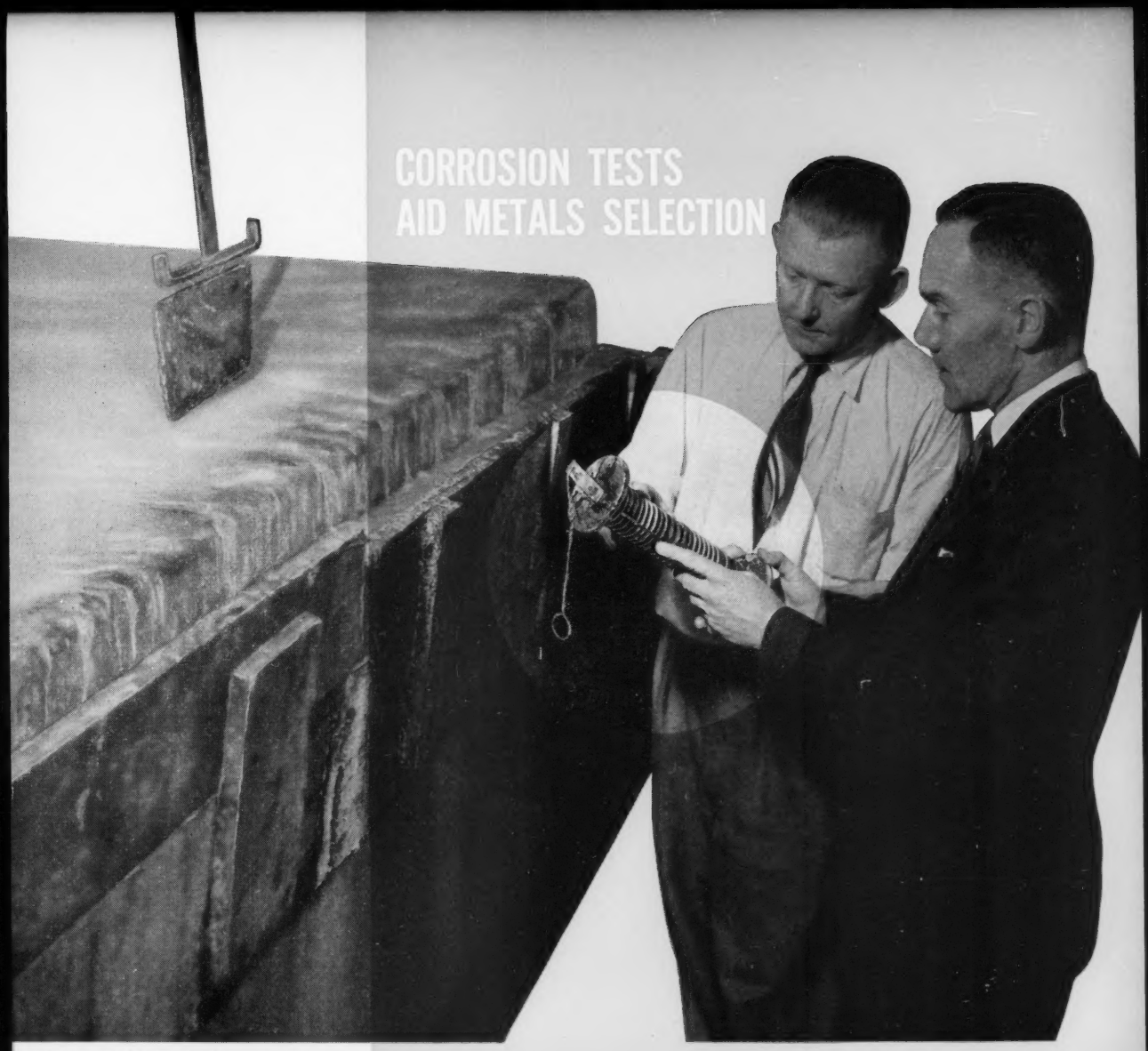
• • •

WESTINGHOUSE ELECTRIC CORPORATION of Pennyslvania has obtained a Canadian patent on a protective system for series capacitors in high voltage transmission lines, said to overcome the problem of providing satisfactory protection for series capacitors in such lines.

The patented system protects the capacitor against over-voltage due to fault currents or other excess-current conditions, but restores the capacitor to service within the first half cycle after the fault is cleared. The inventor: Ralph E. Marbury of Pittsburgh.

Established protective systems, used to protect capacitors in distribution lines, are not satisfactory for transmission lines because there is an appreciable delay of at least several cycles after the current has returned to its normal value; this means that the capacitor is removed from service just when needed most—immediately after the fault is cleared.

The invention—covered by Canadian Patent No. 511,072—is a self-clearing spark gap in series with a resistor connected across the capacitor. The spark gap is adapted to break down and connect the resistor in parallel with the capacitor whenever the voltage is too high. The arc is cleared at each current zero during a fault by a blast of air from a compressed air tank. If the voltage remains below the breakdown voltage of the gap during the next half cycle, the capacitor goes into service again.



orrosion test spool is examined
y plant supervisor and INCO Re-
earch Engineer at Ontario Paper
ompany, Thorold, Ontario.

Let INCO be of service* to you

The above picture shows an INCO test spool which contains a variety of metals and alloys for testing under actual conditions of projected use. Over many years, INCO has made thousands of "on the job" corrosion tests to determine which alloy or metal is best suited for the particular job. This type of close co-operation enables INCO to put its facilities, personnel and experience to the best use in helping Canadian industry. If you have a metals problem . . . let the information and experience available at INCO be of service to you.

**Information involving corrosion, fabrication, foundry problems, high and low temperature service and metals selection.*

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INCO SERVICE GOES WITH INCO NICKEL

DEVELOPMENT AND RESEARCH DIVISION

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED, 25 KING ST. W., TORONTO

Printed Circuits

(Continued from page 41)

the clad. This ease of fabrication is the greatest advantage of etched-foil printed circuit design over systems employing metallic ink, ceramics, and other slower methods.

The only fabricating difficulty sometimes experienced with copper-clad is a slight lifting of the copper foil from the laminate during punching and drilling operations. This is easily corrected by providing close fitting stripper plates for all punching operations and by grinding drills to a negative rake.

Where punched holes must register with the circuit pattern details, great care must be taken to provide precise indexing during the punching operation. The normal practice of heating laminated plastic before punching also applies to copper-clad. Temperatures of 250 to 280 deg. F are best for most general purpose grades.

Printed circuit assembly methods vary. But most are planned around dip soldering as the final operation. Dip soldering is the method of soldering a large number of connections at one go. Component leads are inserted in mounting holes, the proper flux is applied by dipping or brushing and the wired panel is floated (dipped) on the surface of the molten solder.

The soldering is complete, in four to five sec. The panel should be lifted from the solder pool with a tilting motion to allow the excess solder to drain from the circuit. These connections have excellent shock and vibration resistance. A special line of circuit hardware has been developed to fit the design and construction needs of printed circuits. This special hardware includes eyelets, terminal lugs and connections, tube sockets, transformers and controls. These various items are designed for mounting directly to the printed circuit panel which leads to quick assembly.

Assemblies are sealed

Completed assemblies are sometimes sealed by encapsulating (casting) the entire unit in a resin, such as the polyesters, polyethylenes and similar materials. And a wide variety of protective coatings are also used to provide insulation against moisture, fungus, heat, arc and fire and other enemies.

The laminated plastic used in the manufacture of copper-clad Phenolite is a high pressure laminate composed of various base materials and thermosetting resins. Fibrous materials, like paper, cotton fabric, glass or nylon cloth, are impregnated in a continuous process with phenolic, melamine or silicone resin. Impregnated material is cut into sheets and stacked to the best thickness between pressing plates in a hydraulic press. Under heat and pressure, the resin in the treated material is polymerized to form a hard, compact, versatile material. It is all done to high standards of quality control.

The adhesive used has electrical properties equal to the laminate itself, and gives excellent insulation between etched conductors—about 50,000 megohms after 96 hours at very high (90%) relative humidity.

Copper-clad Phenolite is often under heating cycles in printed circuits. Circuits made by the offset process are put through an oven temperature of 250 deg. F to fuse the asphaltum used as an acid resist. The Phenolite is tested and guaranteed to stand up to 250 deg. F for 30 minutes when 6 in. by 6 in. sample is put in a circulating air oven. Most printed circuit solders melt at about 400 deg. F. One inch square test samples of Phenolite are floated on the molten solder surface to prove themselves. An etched circuit will, however, take much higher soldering temperatures than test samples, because the relatively fine lines of the circuit allow the escape of volatile matter.

The problem of heat is also present in the completed circuit. Tubes, power resistors and the confined spaces in which some circuits must operate, create their own heat problems. But the electrical and binding properties of the copper-clad laminate are rarely affected.

They have more to offer

Printed circuits have more to offer even than all this. Quality improves. Once the right circuit characteristics are found, an absolute sameness will be automatic in all the circuits made.

Testing is also simplified. It can be done visually; this means it is quicker, cheaper and, also, test points can so easily be worked into the circuit pattern without extra cost. For the same reasons, servicing costs will go down. Circuits can be quickly traced along clear paths in a single plane and repairs made with a soldering iron.

Printed circuitry is one of those rare discoveries which goes away beyond being simply a modification or improvement. Its impact on electrical products is going to be immense in the future.

Protect Your Ideas

ORIGINALITY can be worth a fortune — if it's handled right. To make new ideas pay off without losing them to competitors usually means legal protection; most ideas can't be kept secret and also put to work.

But patents are not always the answer to the product protection problem. Take a new domestic washer and drier just going into production; there may be nothing patentable in it, but features like new easy-to-see outside controls can often be covered by a design registration. This means that a valuable (and maybe expensive) design idea will be kept from your competitors for 5 or 10 years at a nominal cost.

Let's take a look at another kind of protection—copyright. Suppose you put a lot of time and money into a new catalogue with good selling descriptions and pictures. Part of your catalogue might be handy material for a thrifty competitor to copy—if it weren't for your copyright. And this applies to instruction sheets, which can mean a lot of original work. Drawings, blue prints are also in this class.

By international agreement, copyright is automatic, but you can register if you want to give notice of your rights; over 5,000 copyrights were registered last year.

Another place where a good idea can pay is in the trademark field. But there's a difference here because you can't get protection for a trademark unless you have used it in business. The first person to use the mark to identify his own goods or services—not the first just to think of the idea—can register it for those goods and services. Anyone else can use it for different goods or services.

Does all this mean that every new idea can be protected in one way or another? No. Many ideas can't be protected. For instance. you can't protect ideas for ways of doing business. (Contributed by Roy V. Jackson.)

Nowhere - no, nowhere in Canada can you find a greater selection of copper and copper alloy tubing in small diameters and thin walls

- **Produced in sizes from .0625" O.D. to ¾" O.D.**
- **Wall thicknesses from .005" to .095"**

Do your small-tube requirements call for seamless drawn tube in long coils, in short lengths?

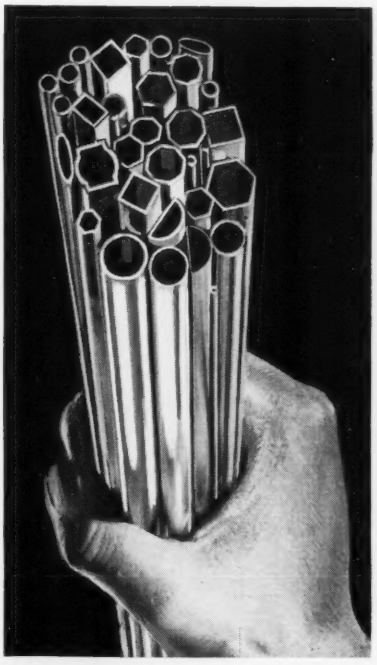
Do you need thin-wall tube, capillary tube, restrictor tube, special shapes or tube for refrigeration and air-conditioning work?

Are you looking for a varied choice of small tube, such as: copper, yellow and low brasses, leaded brasses, cupro nickel, phosphor bronzes, naval brass, Admiralty, Everdur* and commercial bronze.

Only Anaconda offers you this complete selection of small-tube types, sizes and alloys. As usual, you can count on Anaconda to take special care to see that inside surface of all tube is clean, smooth and bright, and that all tube is accurate in size and shape.

If you have a specific need for small-diameter tube consult Anaconda American Brass Limited, Main Office and Plant, New Toronto, Ontario; Montreal Office, 939 Dominion Square Building.

*T.M. Reg.



A FEW OF THE MANY sizes and shapes of Anaconda Small-Diameter Tubes

ANACONDA®

SMALL-DIAMETER TUBES

New products & materials

New items which can help you on the job

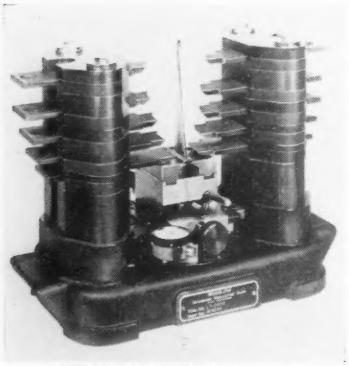
A NEW KIND of guillotine gauge has been placed on the market by **Winslow Manufacturing Company.** Known as the Winslow Standard Guillotine Gauge, the new patented device is assembled from precision-built stock components to give accuracy for less money.

The Winslow gauge is in use by leading members of the aircraft engine industry, to give precision airfoil inspection of jet engine blades.

A new method of construction gives six big advantages: quick delivery, lower original cost and lower maintenance, less gauge down-time and an end to gauge obsolescence with an instrument that is truly "multi-purpose."

The Winslow gauge checks both the forging and the finished part by merely substituting a different holding fixture. Every gauge can be supplied to check up to 10 different features of a blade and, if originally designed to check only part of the list, can easily be converted at a later date to check additional features.

Built to maintain its original accuracy under punishing service conditions, the



Winslow's ten-feature gauge

gauge supports its templates in special guide blocks that distribute wear over a much greater surface area. Alignment is guaranteed by supporting the templates in heavy stacked towers that are bolted together for ruggedness and rigidity.

Replacement of templates due to wear or part changes can be done by the user without removing the gauge from his inspection line. Due to the interchangeable parts feature, down-time for re-working in more extensive parts changes is cut to a fraction of the usual allowance. A complete re-work department is maintained by the manufacturer.

In addition to its accuracy, the Winslow Standard Guillotine Gauge is designed to cut operator fatigue and speed up the entire inspection process. (200)

• • •

BECAUSE OF THE NEED for a quick way of forcing an entry into the fuselages of crashed aircraft, Britain's Ministry of Civil Aviation asked **Black and Decker Manufacturing Co.,** to find a new cutting tool. The company has developed a light, powered Air Rescue Saw which cuts bigger, less jagged holes than has been possible before—and does so quickly.

The difficulty of getting lightness and reliability in an electric saw while keeping a good depth of cut has now been solved. So has the problem of a mobile power supply.

It is planned to provide the powered saw for aerodrome fire services at all important aerodromes in the United Kingdom. These saws will be able to make rescue holes through the depth of the skin by cutting clean through frames and sound-insulating furnishings of an aircraft, should all normal or emergency exits be jammed or inaccessible.

The equipment and its power supply are carried on light rescue tenders, which already carry normal hand-rescue tools. (201)

• • •

A NEW photo-conductive cell, handling power up to 0.3 watts, is announced by the **Canadian Marconi Company.**

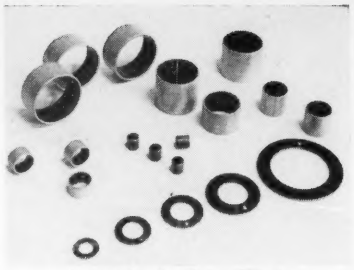
It eliminates the electronic amplifier, the vacuum photo cell and the d-c power supply.

This cell, another outcome of semiconductor technology, is designed to operate relays and other devices of voltages from 110 volts to 1.5 volts a-c or d-c, with incidental light values from daylight (1,000 ft. candle) to the moonlight (0.020 ft. candle). The sensitivity is 0.40 amperes per lumen the company claims. (202)

• • •

THE LATEST CONTRIBUTION, by the **Glacier Metal Co. Ltd.,** of England, to the field of bearings are their dry bearings (DP series).

The DP series bearings are manufactured from steel strip on to which has been sintered a layer of porous bronze. This porous lining is in turn impregnated with polytetrafluoroethylene (PTFE), and the resultant is a bearing that will provide satisfactory service without the aid of a liquid lubricant, and yet will still



A contribution from Glacier

operate successfully in the presence of such lubricants.

Another important feature is, that due to the chemical inertness of the PTFE it may be used for applications where corrosive liquids, such as would attack the more conventional bearing materials, are present. (203)

• • •

RECENTLY PRODUCED is a rugged rocker-arm welder for light production work. Designed by **Progressive Welder of Canada, Ltd.,** it can be used for a wide range of spot welding jobs, from light to medium duty. Setups are made quickly and easily for all kinds of jobs.

The rocker-arm welder is made with a heavy welded steel frame to provide strength where needed. A special removable panel allows full easy access to enclosed parts.

Other machine features include indidually controlled three-circuit water cooling with sight gauges, 8.8 selector, airline controls and accessories, speed control valve, interchangeable retractable stroke or standard cylinder, self-lubricating bearings, and many other up-to-date spot welding developments. (204)

• • •

A JOINT EFFORT by **General Electric** and the **Consolidated Edison Co.,** may revolutionize transformer construction.

The big change is the use in high-voltage power transformers of an insulation gas with high dielectric strength.

This kind of dry type unit, filled with sulphur-hexafluoride gas, may eventually take the place of present day oil and askarel filled transformers. (205)

• • •

THREE YEARS AGO the **Dexter Lock Co.,** had a real problem. Both cold-rolled and tool steel holding pins, for buffing lock strike plates, were quickly chewed up. In fact, pins were used so fast that an automatic screw machine was pressed into service to keep up with the pin turn-over.

Today there is no such problem because they are using carboloy carbide pins (grade 883, CGE) a little longer than the eraser-end of a pencil and 5/32 in. in diameter. After three years of being buffed and rubbed with buffing compound they are still taking it. (206)

An art gallery isn't the only place where design can cause a headache—but when tubing comes into the picture there's no need to reach for the aspirin. Our technical staff's first hand knowledge of tubing application is helping eliminate design headaches in almost every branch of Canadian industry.

Stan Steel

WELDED AND SEAMLESS TUBING

STAN STEEL 50 YEARS OF GROWTH WITH CANADA

STANDARD TUBE AND T. I. LIMITED • Woodstock • Toronto • Ottawa • Montreal

New products *(Continued)*

A SELF-CONTAINED combination tester for checking thermocouple output and temperature has been added to the line of

A new self-contained tester

instruments and controls offered by **Robertshaw-Fulton Controls Company.**

The new tester is designed for convenient checking of the millivoltage output of thermocouples in both open and closed circuits, from 0-50 and 0-1,000. It is suited for testing either single thermocouples or multiple thermocouple installations.

It will also accurately check temperatures, within the range from room up to 650 deg. F, of water heaters, ovens, dryers, heat treating installations, and other commercial and home appliances.

The tester will automatically compensate for changes in ambient temperature, a company announcement said. It is contained in a sturdy carrying case, which has a compartment for thermocouples. Replaceable calibrated thermocouples are also available at moderate cost.

Binding posts on the instrument are color-coded to prevent errors in connecting lead wires. A special vinyl meter front and larger meter pointer ensure easier reading. A tester is simple to operate and comes complete with all necessary instructions, it was added.

The price of the new instrument is $28.50, its weight is 3 lb. 3 oz. (207)

• • •

A NEW TYPE of silicone rubber, with several important features, has just been announced by the Silicone Department of **Linde Air Products Co.,** a division of Union Carbide and Carbon Corporation.

It is available in Canada in production quantities as a gum stock called W-96 Silicone Gum.

The particular properties of W-96 according to Linde depend on the controlled number of reactive groups that have been built into each silicone molecule. These reactive groups determine the final structure of the cured rubber. It is this controlled reactivity that gives advantages in curing the rubber, as well as special products in the cured product. As far as can be seen, this new gum will do all that methyl silicone gums and their compounds can do, at the same time having many striking advantages.

Unusually low compression set is one of the properties that Linde sees as being of particular importance to design engineers, particularly as these very low values are present over a wide range of hardness, using conventional fillers.

The small sacrifices of tensile and elongation increases the significance of these values. This means that W-96 is better than other silicone rubbers for gaskets, O rings and many other molded parts that concern design engineers. (208)

• • •

A NEW TYPE OF watt-hour meter, known as the I-55, introduced by the **Canadian General Electric Co.,** features a rotor assembly which floats in a magnetic field.

The I-55, a three-wire single phase 100 amp. meter, joins the I-50 family of meters developed several years ago by General Electric Co. in the U. S. It is designed to replace the I-30 meter which has been the standard for the industry for more than two decades. With more and more electric-powered appliances in the home, the time will come when the meters now used in Canada will be unable to cope with the load. In the I-55 the range of accuracy is better and at the same, through the use of new materials and a complete redesign, the meter will operate longer without maintenance. Incidentally, the range of the I-55 is from 15 watts starting load to a peak of 23,000 watts, which is a considerable increase over the present standard of from 15 to 13,800 watts.

The main feature of the instrument is the magnetic bearing system used in the rotor assembly. The rotor literally floats on air. Mounted in the top of the frame is a magnet of high coercive force. The upper end of the disc shaft also contains a smaller magnet of similar material concentrically located.

So, instead of a bearing support, involving friction, the shaft is supported by the inter-action of two magnetic fields. Guide pins, set in graphite bushings, are used merely to keep vertical alignment of the rotating element.

Among the new materials used is high dielectric strength butyl rubber. The new stator coils are molded directly to the core with butyl, thus giving greater rigidity, and this, coupled with butyl's long life, gives calibration stability and accurate operation over years of service.

The register of the I-55 has also been redesigned for easier reading. (209)

• • •

HIGH PRESSURE transients, too rapid for conventional transducers, are easily measurable with two new electrical resistance-type pressure pickups recently released by **Consolidated Engineering Corp.** The new pickups were designed to measure gas and liquid pressures in the higher ranges for petroleum field-work, chemical plants, missile testing, and so on.

The miniature pickups are available in gauge and absolute models which feature high corrosion resistance and a flush-type diaphragm. The Type 4-313 is designed for general-purpose measurements and provides for flange-type mounting, while the Type 4-314 is supplied with a threaded case for hydraulic system applications where it is desirable to have diaphragm and liquid flush.

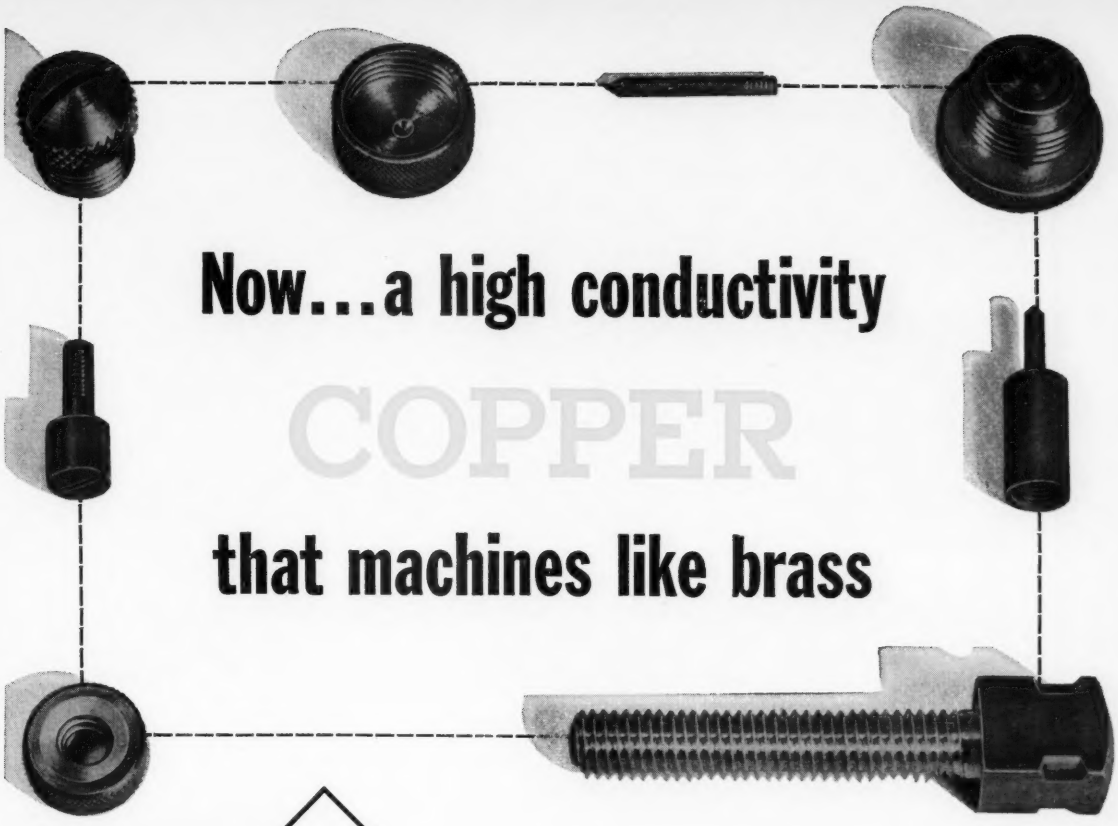
The pickups are available in 1,000, 2,000, 3,000, and 5,000 psi gauge and absolute ranges, with other ranges available on special order. Each pickup weighs approximately 50 grams. The Type 4-313 is 0.625 in. in diameter, while the Type 4-314 is 0.75 in. Each pickup is a nominal 1 in. in length.

The variable-resistance sensing unit incorporates a 4-arm bridge to convert changes in diaphragm pressure to proportional change in voltage output. This output can be permanently recorded with an oscillograph or observed visually on an oscilloscope or meter.

Performance characteristics include: 20 mv open-circuit output, full scale, on all pressure ranges at 5-volt d-c or a-c (rms) excitation; linearity deviation of less than ±1.0% of full-scale output; in-

Two new pressure pickups

put-output impedances of 350 ohms; static acceleration response of less than 0.01% full scale per "g"; and natural frequency above 20 kc. (210)



Now...a high conductivity COPPER that machines like brass

Noranda

TELLURIUM COPPER

Here is a real money-saving material for parts that must have high conductivity yet require machining. Noranda Tellurium Copper has an electrical conductivity 90% of electrolytic copper, and an unusually high thermal conductivity. Yet Noranda Tellurium Copper's machinability rating is high...90% of free-cutting brass, compared to 20% for electrolytic copper. Precision tolerances can be maintained with less wear on tools.

Using this metal, you can increase screw-machine speeds up to four times faster than those recommended for electrolytic copper. Yet tooling required to work Noranda Tellurium Copper is the same as that used on free-cutting brass.

Start pocketing those production savings now. Contact your nearest Noranda Sales Office for immediate service on Tellurium Copper and other high quality brass mill products.

Noranda Copper and Brass Limited

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Quotes

Points from current papers and speeches

IN A RECENT SAE paper delivered by **G. W. Church** under the heading **A New Airborne Weather Radar,** he stated that as the various obstacles to the complete safety of aviation have been overcome, those still remaining assume larger relative importance. Such a remaining obstacle is the thunderstorm, whose turbulence results in passenger discomfort, delayed schedules and severe stresses on aircraft structures.

Airborne radar is an important aid in the early detection and location of thunderstorm areas in flight; it allows circumnavigation or penetration through their less turbulent portions.

The units which comprise the Bendix Airborne Weather Radar are an antenna, a transmitter/receiver, a synchronizer/power supply, an indicator (with removable viewing hood) and a control panel.

The antenna is mounted in the nose of the aircraft, under a radio-transparent but optically opaque dome fitted to the aircraft contour. It continuously scans the area in front of the plane at a rate 15 rpm. The transmitter-receiver unit and the power supply unit are mounted in the ship's radio rack in accordance with the standard airline practice of keeping the electronic units in the pressurized area. The control unit is mounted in the cockpit convenient to the pilot and co-pilot. Both the pilot and the co-pilot have indicators, mounted where they can be easily observed in flight.

The face of the indicator is a long persistance cathode ray tube, displaying a plan map of the area over which the aircraft is flying. With the antenna pointed slightly down, the return from the ground is painted in, showing in outline the coast lines, rivers, cities, mountains and terrain features, much as they might be drawn on a map. The airplane's position is at the point of a black inverted V. Three sweep ranges are provided on the indicator, giving each pilot individually a choice of a 20 mile, 50 mile or 150 mile display, as measured from the aircraft position to the top of the indicator. The range of display is reduced in the left and right directions by the geometry of the display, and no picture is provided directly to the rear because the antenna in the nose cannot see through the aircraft. Range marks are provided at convenient intervals on the display, and radial marks are provided at 30 deg. increments of azimuth. A hood snaps onto the face of the indicator to provide shielding from the light when operating in a bright cockpit in daylight.

Isoecho circuits were incorporated in the radar to display a contour of storm intensity. That is to say, the outer edge of the white area of a rain return defines the rainfall rate at which echoes are visible on the radar (near zero rain). The outer edge of the black hole in the centre outlines the area within which the rainfall rate is greater than this by a preset amount (usually 12 to 16 db). Where the rate of rainfall changes rapidly, maximum turbulence is normally found.

There are three main operational uses foreseen for this equipment. They are: (1) avoidance of thunderstorm turbulence (2) ground mapping and (3) beacon navigation (beacon navigation is restricted to the X band system at present, since no C band ground racon stations are in existence). The order of importance of these uses remains to be determined by extensive field usage, and by the particular problems of the user.

• • •

THE THREE SPEAKERS at a recent SAE lecture, **Air Force Experience with Synthetic Lubricants,** were **T. F. Davidson, T. P. Cooley** and **J. H. Way.**

They stated that the Air Force has been using synthetic gas turbine lubricants, in quantity, for the last four years. The experience obtained with these lubricants, although varying, has for the most part been satisfactory. This experience has been broken down into three categories, laboratory, engine and material—experience with each subject being discussed in some detail. The reasons for using synthetic lubricants and the need for improved lubricants are also discussed.

Before discussing synthetic lubricants, they summarized briefly the reasons why synthetic lubricants are used. Early jet aircraft power plants used mineral oils as lubricants with excellent success. These oils, covered by Specification MIL-0-6081, are still widely used for such engines as the J33, J47 and J48.

However, with the advent of higher performance engines such as the J57, J65, T-34 and T-56, it became necessary to use synthetic based oils. The previously used mineral oils were unsatisfactory for the higher performance engines because of their high coking tendencies, high evaporation loss at elevated temperatures, and their lack of sufficient load-carrying ability to lubricate turboprop engine reduction gears.

Accordingly, after evaluation of prototype formulations from the petroleum industry and research organizations, and with invaluable assistance from the engine builders and the Bureau of Aeronautics, the Air Force, in December, 1951, issued a specification, MIL-L-7808, establishing the requirements for a synthetic based lubricant. This specification was written around an Esso Standard Oil Company formulation, WS-2211, now marketed as Esso Turbo Oil 15, using Pratt and Whitney Aircraft Specification No. 521 as a guide. Since December 1951, approximatey 750,000 gallons of this oil have been produced, of which some 250,000 gallons were supplied to the Air Force.

Today Specification MIL-L-7808 oil is used to lubricate the engines of all advanced Air Force aircraft, including such aircraft as the B-52, B-57, F-100, F-102 and many others. At the present time, the authors do not foresee any future gas turbine engines or advanced aircraft which will not use a synthetic oil, be it of the MIL-L-7808 type or an improved version.

• • •

A CONFERENCE, sponsored by the ASTE National Education Committee, was recently held on the subject of preparing engineers for manufacturing responsibilities.

One of the speakers was **Ralph J. Smith,** Head, Engineering Department, San Jose State College who stated that although over 40% of the engineers in this country are employed in the manufacturing industries, specific training for the manufacturing function is a relatively new development. The majority of engineering curricula are directed toward design, even though only 15% of American engineers are engaged in this function. Obviously there is need for greater emphasis on training for manufacturing;

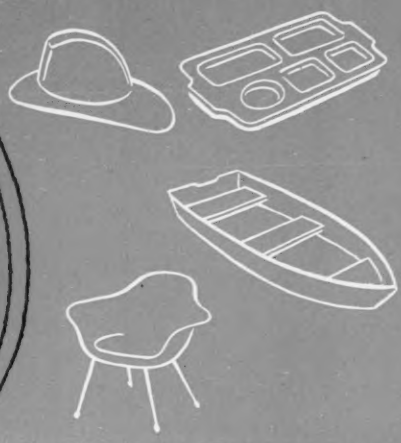
The traditional division of engineering into branches such as civil, mechanical and electrical is in terms of what the engineer **works with**. From the standpoint of training, a much more meaningful classification is in terms of **functions** which are related to what the engineer **does.** The major functions are research, development, design, construction, production, operation and maintenance, application and sales, industrial and management.

A certain type of individual is needed for research whether it is in the field of elasticity or electronics. Also, the viewpoint and training required to design a bridge are basically the same as those necessary to design an aircraft fuselage The function classification is a much better basis for discussing aptitudes and engineering training.

What's new in

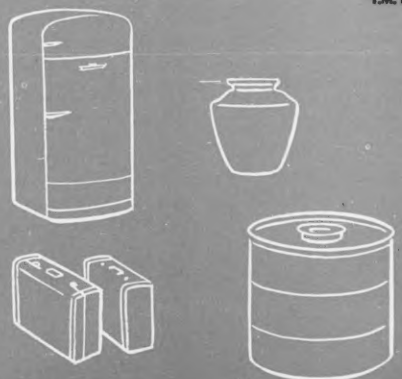
F.R.P.?

FIBERGLAS REINFORCED PLASTICS

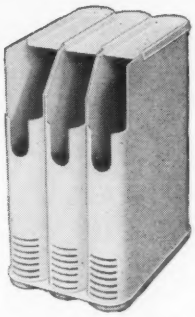


Many manufacturers are finding that they can cut costs and improve their product by the use of F.R.P. With a strength-weight ratio in excess of any other known material, these plastics make it possible to fabricate lightweight articles of amazing strength and durability. Perhaps F.R.P. is what *your* product needs to put it out front in sales and consumer acceptance.

*T.M. Reg'd.



CASE HISTORY OF THE MONTH



The excellent electrical resistance of FRP is illustrated in this switch-gear housing. It has been tested to 40,000 amps and 4,000 volts, yet it is a quarter the thickness of the usual paper phenolic laminate and much lighter. Only 5 parts have to be assembled to complete the housing . . . 24 were required before FRP was adopted. Moulded by Humphrey-Cosburn Plastics Engineering Co., Markham, Ont., for Canadian General Electric Company.

FIBERGLAS*

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FIBERGLAS CANADA LIMITED

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FOR
SHOCK
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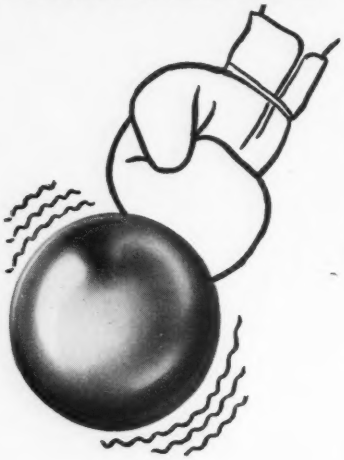


USE
ABBOTT BALLS

When the ability to "take it" is a factor in the selection of bearing balls, be sure to ask for Abbott — "the ball with the Armored Heart".

Cold forged from selected carbon steel wire, every Abbott Ball is DEEP HARDENED and TEMPERED. This gives it extra stamina to perform efficiently under high load factors and withstand jarring shocks.

Abbott Balls are unsurpassed for sphericity, size tolerance and other essentials of fine carbon steel bearing balls.

Specify Abbott . . . you can't ask for a better ball.

The ABBOTT BALL CO.

100 Railroad Place
Hartford 10, Conn.

So what do you say chief? Do we start producing?

Slip Rings Step Forward

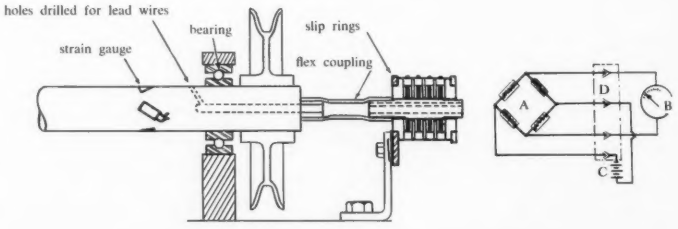
NEWLY DESIGNED mercury slip rings are a big step forward from earlier attempts to measure shaft torque. Once, strain gauges with copper slip rings and ordinary carbon brushes were used. They were not very successful. So much electrical noise came from resistance changes in brush contact that the signal was lost.

Later on, rings of pure silver were used. The signal was picked up from them by three or four graphite brushes on each ring — but again there were troubles. The assembly was expensive and bulky; it could only be used where there was plenty of room.

The new mercury slip ring method, on the other hand, is simple. The four resistance wire strain gauges (120 ohms each), (see picture) are cemented to the torque shelf. An axial hole is drilled from the end of the shaft to the lead wires from the gauges past the bearing.

One lead wire is connected to each of the four copper discs mounted on the hollow spindle of the slip ring assembly. Each of these discs is surrounded by a solid copper ring and to this the instrument lead wires are connected. The spindle, end bearings and dividers between collector rings are of nylon chosen for its insulation and wear resistance properties. A few drops of mercury in each compartment provide contact.

The electrical circuit shows four resistance wire strain gauges connected in a Wheatstone bridge arrangement (A); a voltage represented by battery (B) is applied across the bridge and the output from any unbalance is measured by instrument (B) which is normally an oscillograph. Slip ring connections are represented by (D). ★



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111 RICHMOND STREET WEST
TORONTO 1 EM. 5-0119

COMMON CHARACTERISTICS OF ALL TYPE 2131 GEARED MOTOR GENERATOR UNITS

O.D. of Case . . .1.000 inch
Case Length 3.301
Weight . . . .7.5 ounces
Frequency . . . . . .400 cycles

No. of Poles (Motor) . . 6
*No Load Speed (Min.) . 6500 rpm
Rotor Inertia . . . 1.1 gram-cm²

*Motor Speed at input to gear train

NEW integral gear head in small servo motors

OUTSTANDING FEATURES OF TYPE 2131 GEARED MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt—115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2028	Motor Generator

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. An unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

INPUT PER PHASE ONLY 1.8 WATTS

ELECTRICAL CHARACTERISTICS
OF TYPICAL TYPE 2131 GEARED MOTOR GENERATORS

Latest catalog and/or complete specification drawings will be sent upon request.

				MOTOR		GENERATOR		
TYPE NO.	EXCITATION FIXED	EXCITATION CONTROL	INPUT PER PHASE	STALL TORQUE	Theoretical Acceleration At Stall	EXCITATION FIXED	INPUT	OUTPUT PER 1000 rpm
2131-0411110	26	26	2.3	0.4	25600	26	1.8	.51
2131D-0412120	26	26	4.0	0.6	38500	26	2.2	.68
2131D-0413120	26	26	1.8	0.3	19200	26	2.2	.68
2131-0460600	115	115	4.0	0.6	38500	115	2.6	1.00
2131-0463600	115	55	4.0	0.6	38500	115	2.6	1.00
2131-0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec²	volts	watts	volts

SPERRY GYROSCOPE COMPANY OF CANADA LTD.

CANADIAN REPRESENTATIVES FOR KOLLSMAN INSTRUMENT CORPORATION, SUBSIDIARY OF STANDARD COIL PRODUCTS CO., INC.

File

New booklets and books written for you

DETAILS ARE GIVEN of a vapour phase inhibitor (VPI) in a brochure of the **Shell Oil Co. of Canada Limited.**

It is the modern approach to the critical problem of rust prevention in relatively confined areas. Crystalline in form, it is a slowly vaporizing corrosion inhibitor which preserves the surface of metal by forming a protective atmosphere. It does not act by removing moisture or oxygen, but functions in the presence of these corrosive inducing agents.

It is moderately soluble in water, very soluble in methyl alcohol, less soluble in higher molecular weight alcohols, slightly soluble in certain other solvents and practically insoluble in hydrocarbons; it is claimed to be easy, quick and economical to apply: to provide corrosion protection over a wide range of atmospheric conditions: to be free from objectionable characteristics. In addition, it does not need to be removed before equipment is used. (211)

• • •

BULLETIN DP9-54 of the **Cannon Electric** . . . deals with a wide range of unit plug-in connectors.

The types covered include miniature, medium size and standard size, dual insert and special function types.

Mounting data, wiring and assembly are also dealt with and illustrations show typical applications . (212)

• • •

A BROCHURE on vacuum metallizing, published by the **F. J. Stokes Machine Co.,** explains that vacuum metallizing is the deposition of metal or alloys under high vacuum conditions on surfaces of plastic, metal, glass, paper, textile or other materials. It is a simple, cheap production process which gives a lustrous metallic finish for both decorative and functional purposes.

Vacuum metallizing, as a modern industrial process, has developed rapidly during recent years from laboratory levels to a production method finding application in many areas of industry. Day by day, industry proposes new uses for this process. (213)

• • •

A HEAT-CURING adhesive known as FM-47 developed by bonding highly stressed structural components is described in a bulletin of the **Bloomingdale Rubber Company.** In many cases it can be used, it is claimed, to replace more expensive methods such as riveting, spot welding and so on.

This adhesive is suitable for all materials, organic and inorganic, except for a few synthetic elastomers. High strength and durable bonds can be obtained with aluminum and magnesium alloys, steel, copper, brass, plastic laminates, glass, ceramics, wood, leather and fabric.

Details given in the bulletin include shear block tests, double lap and single lap shear tests, single lap bond tests, characteristics of bonds and bonding procedures.

Details are also given of FM-47 adhesive film. (214)

• • •

A BROCHURE by the **Warnock Hersey Co. Ltd.,** shows pictorially the principal services of the company.

Their industrial activities include complete testing of paints and electroplated or sprayed metal coatings; complete physical and chemical tests of metals, including non-destructive testing (ultrasonics, X-ray and gamma ray); approval of stationary and transportable pressure vessels; shop and field inspection of valves, regulating gates and turbines. (215)

• • •

BULLETIN 200-C deals with the self-aligning spherical roller bearings of the **Torrington Company.**

Although the spherical roller bearing is a comparative newcomer to the field of anti-friction bearings, it is already widely used when there is need for rugged, self-aligning bearings that compensate for shock loads or shaft misalignment.

• • •

A BROCHURE published by **B. F. Goodrich Chemical Co.,** deals with plastic stamping of Geon polyvinyl materials.

These vinyl plastics were designed to provide sheet material with high physical strength, shock resistance, dimensional stability and increased extensibility at forming temperatures. Geon Polyvinyl chloride resins and compounds (based on the resins) are supplied in the form of powder and granules.

Calendar sheet made from these materials may be obtained from a number of suppliers. The sheet is available in rolls of any convenient length and in thicknesses up to 0.04 or 0.05 in. Generally, 48 in. is the maximum width for the thinner gauges and somewhat less for the heavier gauges. The vinyl sheeting may be obtained with one or both sides embossed with a pattern. The forming operation does not destroy this finish.

At the present time stock thicker than 0.04 or 0.05 inches is not available in rolls for continuous feed. However, single sheets may be produced in thicknesses up to ½-in. by laminating thin sheets in a press. The heavy stock requires no special handling other than reasonable care to ensure that it is heated uniformly.

The following are physical properties of a typical calendered sheet based on Geon high impast resins; specific gravity 1.35, tensile strength 6,000 psi, flexural strength 12,600 psi, Izod impact strength 5 ft-lb per inch of notch, heat sag temperature 155 deg. F, forming temperature 260 to 275 deg. F. (216)

Book Department

Adhesive Bonding of Metals

ADHESIVE BONDING OF METALS by **George Epstein** gives sufficient details for an engineer or technician, faced with the problem of joining two materials, to decide whether an adhesive bonded joint would be sound, what type of adhesive to select, how to use the adhesive, and how to design the joint for optimum performance. In particular, adhesives are considered which are most generally employed with metals.

In order to familiarize the reader with the physical and chemical properties of adhesives, a discussion is given of the chemistry and formulation of adhesives, especialy in relation to the properties of the cured adhesive bonds. A rather extensive treatment also is presented of the various factors affecting the strength of adhesive bonds, including the concept of joint factor and its use. Sandwich construction is considered in some detail, especially with reference to the roles played by adhesives.

An entire chapter is devoted to elevated temperature resistant adhesives for metals.

The increased operating speeds of aircraft and developments in missiles call for adhesives which are capable of withstanding high stresses at elevated temperatures (about 500 deg. F). Within the past few years rapid progress has been made along this line and such materials are now becoming availabe. The author, who is especially familiar with this phase of adhesives, has had the opportunity to make many research contributions.

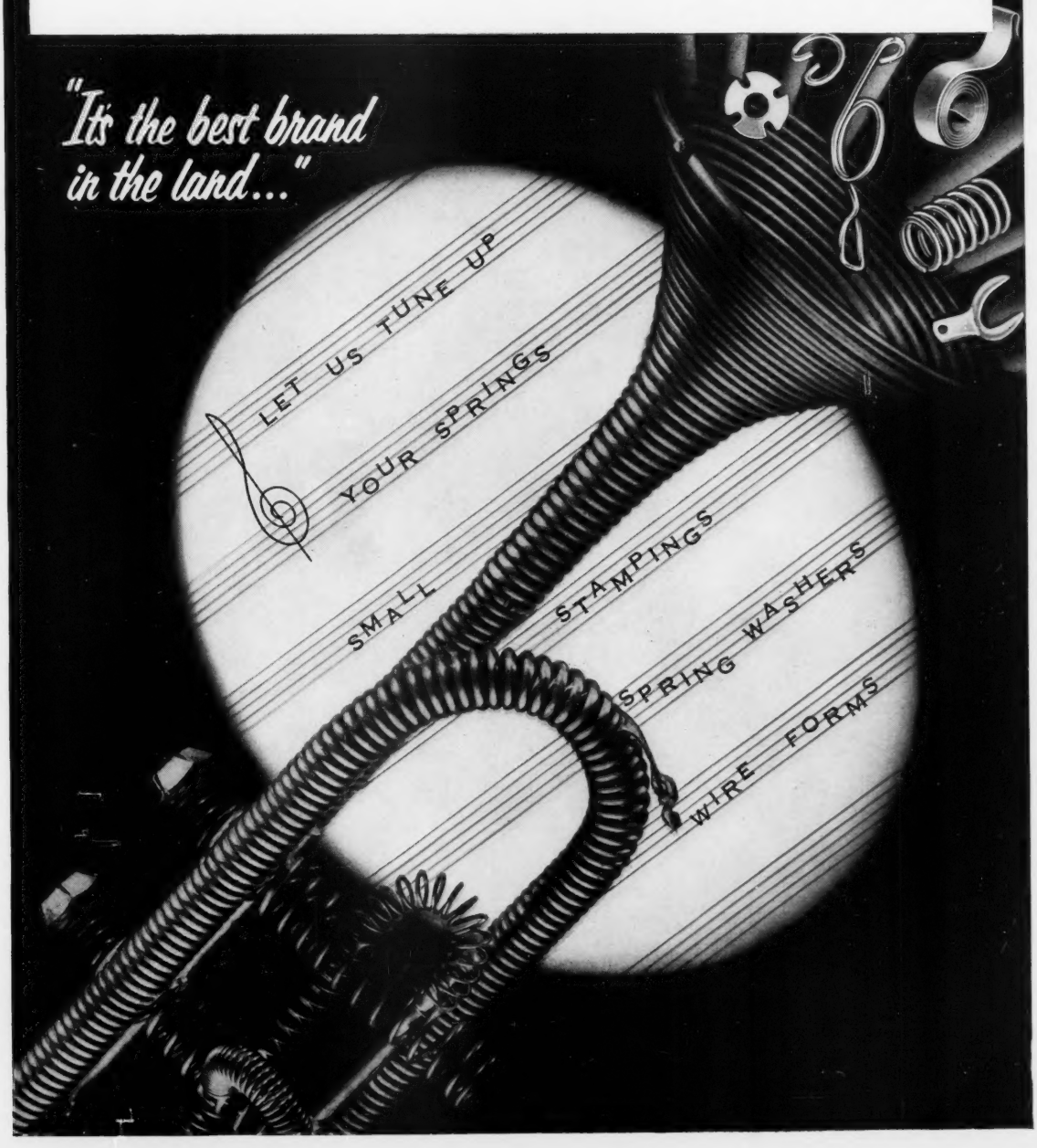
The book is well produced and justifies the author's claims outlined above.

It is a useful reference book for any design engineer interested in the subject of the adhesive bonding of metals well worth having on your shelf.

Wallace Barnes SPRINGS

The Wallace Barnes Co. Ltd.

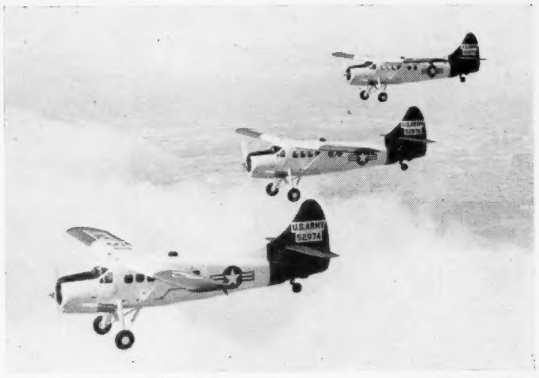
HAMILTON, ONTARIO



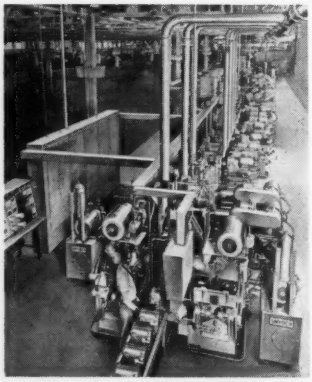
Design news in pictures

Some modern designs making news today

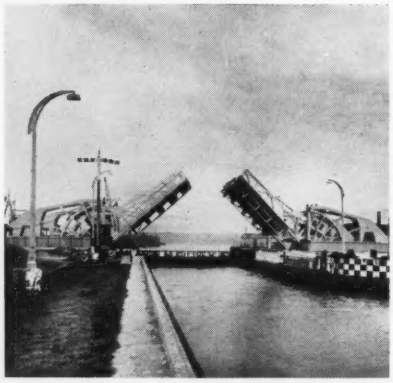
Long-distance CPR diesels now carry two steel cross bars on each engine to break off long icicles which hang from tunnels and threaten the new scenic domes.



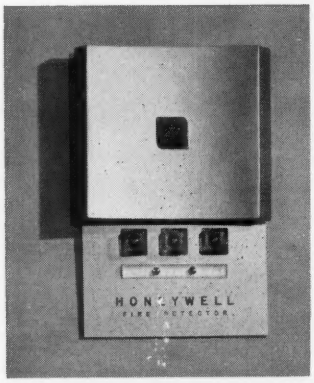
American General Ridgeway has now accepted the first of 90 De Havilland of Canada Otters on order by the U. S. army. Red tips, tail are for arctic conditions.



This transfer machine by Snyder turns out 100 car transmission cases hourly operated by 1 man.

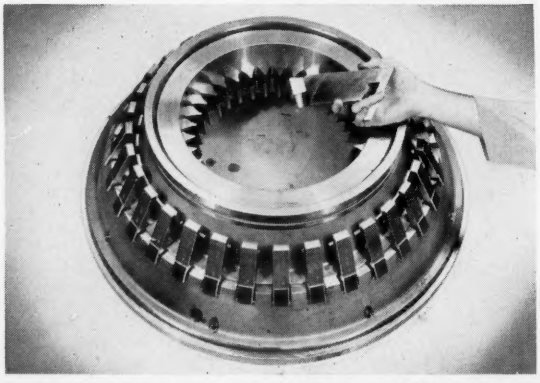


This new bascule type bridge has been patented by its Scottish designer. It has alumalloy cold drive rivets, novel balances.



For their new fire alarm panel Honeywell called in industrial designer Dreyfuss, who did this.

A neat way of handling rush hour bus passengers is coming now from Canadian Beaver. They also design special-purpose turnstiles for big department stores.



Cutting head of a new shaping machine put out by Michigan Tool cuts gears faster than ever before. Low cost is claimed for it with long-run accuracy.

Whatever you make, there's a

WALDES TRUARC RETAINING RING

designed to save you material, machining and labor costs

basic types

BASIC		INVERTED	
#5000 *(internal)*	#5100 *(external)*	#5008 *(internal)*	#5108 *(external)*
Tapered design principle permits rings to maintain constant circularity and pressure against bottom of groove.		Inverted construction provides uniform protruding shoulders while maintaining constant circularity when installed in groove.	

for taking up end-play

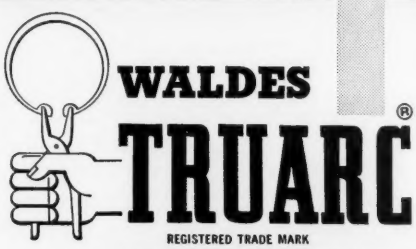
BOWED		BEVELED	
#5001 *(internal)*	#5101 *(external)*	#5002 *(internal)*	#5102 *(external)*
Bowed construction permits **resilient** take-up of end-play.		Beveled construction permits **rigid** take-up of end-play.	

for radial assembly

E-RING	CRESCENT	INTERLOCKING
#5133 #5131 *(bowed)*	#5103 *(external)*	#5107 *(external)*
Radially applied. Provides large shoulder on small shaft diameter. Bowed version provides take-up of end-play.	Applied radially over shaft. Secure against impact and vibration.	Two-piece ring applied radially. Secure against extremely high r.p.m.'s and heavy thrusts.

self-locking types

CIRCULAR SELF-LOCKING		TRIANGULAR SELF-LOCKING	TRIANGULAR NUT	GRIP-RING
#5005 *(internal)*	#5105 *(external)*	#5305 *(external)*	#5300 *(external)*	#5555 *(external)*
Installed axially. Requires no groove. Recommended for permanent assemblies exposed to relatively moderate thrusts, impacts or vibrational loading.		Low cost retainer. Makes possible tight assemblies free of end-play on relatively soft shafts.	Flattens under torque. Secures equal load distribution. Replaces lock washer on screw.	Applied axially on shaft. Requires no groove. Exerts considerable frictional hold against axial displacement.



Redesign with Waldes Truarc Retaining Rings and cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins . . . there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc rings are precision-engineered . . . quick and easy to assemble and disassemble . . . always circular to give a never-failing grip . . . and they can be used over and over again.

Find out what Waldes Truarc Retaining Rings can do for you cost-wise. Submit your blueprints and the Lyman Technical Engineering Staff will give them individual attention without obligation.

Complete stocks are conveniently located throughout Canada.

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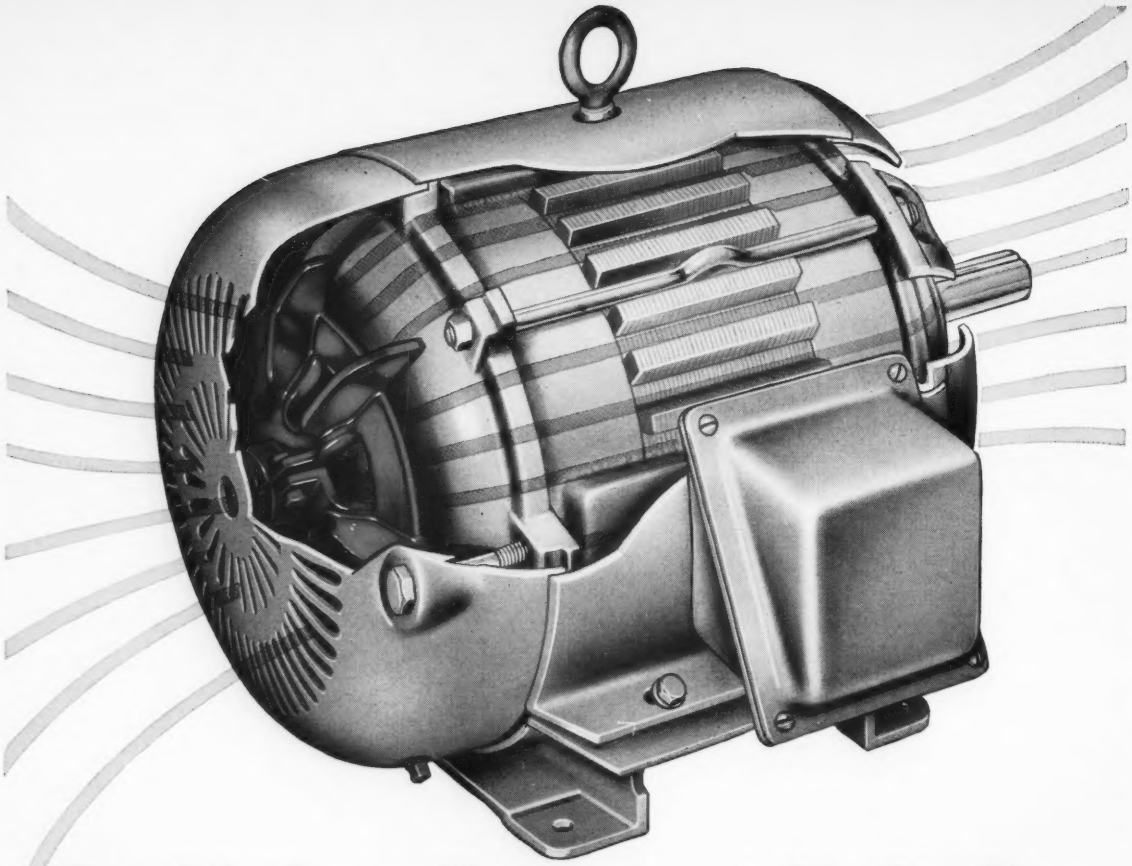
MONTREAL TORONTO WINNIPEG VANCOUVER

Representative: New Glasgow, N.S.



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The double steel frame construction of Wagner Totally-Enclosed, Fan-Cooled and Explosion-Proof Motors permit full-length cooling for continuous, heavy-duty operation.

The better appearing, streamlined contour forces the cooling air over the inner frame and jet-directs it onto the shaft end bearing.

The inner frame forms a permanent protection to the vital motor parts against the intrusion of dust, dirt, metal chips, and other foreign matter. The outer steel casing can be easily removed for cleaning where severe, heavily dust-laden conditions are encountered.

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Division of:
SANGAMO COMPANY LIMITED
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Also sold by the Northern Electric Co., Limited

reader's service

Would you like further facts about advertised products in this issue?

LET OUR READER'S SERVICE department help you with full information about any product advertised in this issue of **Design Engineering.**

- This is all you have to do: Each advertisement is indexed alphabetically. Turn to the index where you will find the advertisement that interests you listed with two numbers beside it. One of these numbers is the page, the other the Reader's Service identification number — set in bold face type.

- On the postage-free tear-out card (this page) circle the identification number — and mail the card.

- Quickly the Reader's Service department will be working for you. All available information will be mailed at once to help you build a useful up-to-the-minute library from the technical booklets, pamphlets and pictures prepared for your use.

- Two Reader's Service cards are provided to allow two readers to make use of the service where copies of **Design Engineering** are passed on.

- There is, of course, no charge for this service and no obligation.

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- Following each announcement on the New Products and File pages are identification numbers in brackets.

- This is all you have to do: Circle the corresponding numbers of any items that especially interest you on the postage-free tear-out card on this page. Then mail the card.

- Quickly the Reader's Service department will be working for you. All available information will be mailed at once to help you build a useful up-to-the-minute library from the technical booklets, pamphlets and pictures prepared for your use.

- Two Reader's Service cards are provided to allow two readers to make use of the service where copies of **Design Engineering** are passed on.

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Letters

Readers' viewpoints . . .

● Mr. B. A. Avery, in his letter in your May issue, points out very clearly and forcibly the lack of faith in Canada which leads to the export of Canadian brains to other countries.

While agreeing with Mr. Avery, I wish to emphasize another equally regrettable result of this lack of confidence in ourselves — namely the tendency of many Canadian industrialists and governmental bodies to import non-Canadian engineering services.

Doubtless this may sometimes be justified by special circumstances, but all too often it comes from an uncritical acceptance of the idea that anything from the U. S. must be better than the thing from Canada.

This aspect of the question was the subject of "Let's be Canadian" — the presidential address of Mr. John B. Stirling MEIC, at annual meeting of the Engineering Institute of Canada at Halifax, two years ago.

L. F. GRANT HON. MEIC
Field Secretary, EIC

Toronto.

● If you want my opinion, I can only say that the first copy of DESIGN ENGINEERING looks to be just about the finest trade publication that I have seen come off the press in Canada.

Congratulations.

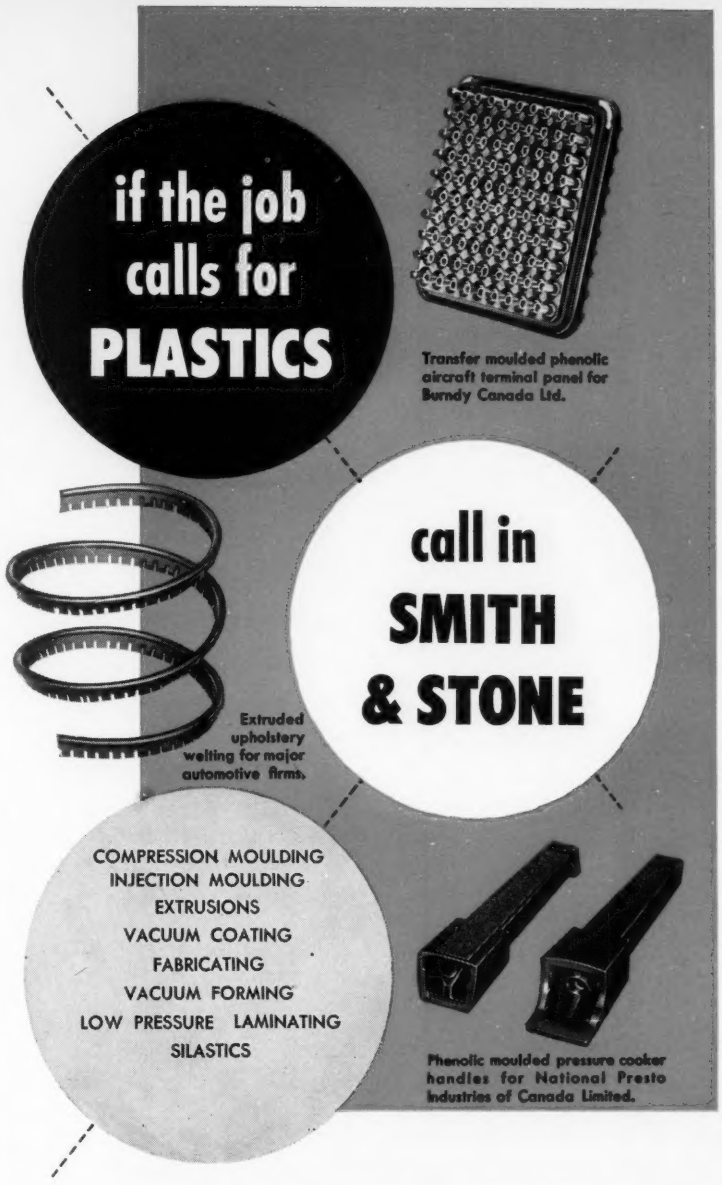
DON ROBERTSON
Heggie Advertising Co.

Toronto

● We enjoyed reading Mr. Norton's article on torsional vibration. Your publication is doing a real service to industry to bring such timely subjects to the forefront.

I am taking the liberty of enclosing a paper which I recently wrote for the Society of Naval Architects and Marine Engineers. This paper was written without recourse to mathematical derivations because it was intended to meet the need of operators and owners. It gives several examples of failures due to torsional vibration and results of proper corrections.

If at some later date you would care to run an article on the more practical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Phenolic moulded pressure cooker handles for National Presto Industries of Canada Limited.

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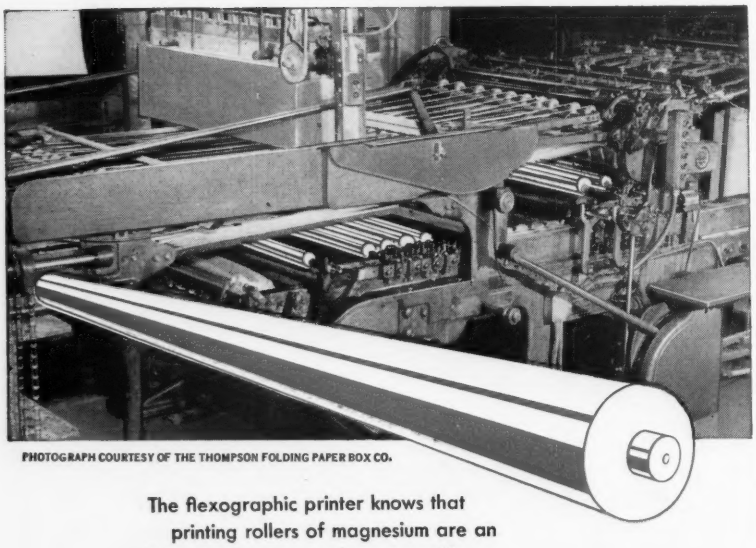

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aspects of this subject, we should be glad to hear from you.

T. W. SPAETGENS
Consulting Vibration Engineer
Vancouver.

Vibration expert Spaetgens is thanked for his offer which is now being considered. There is certainly more to be said about problems of roughness in today's high compression engines and DESIGN ENGINEERING looks forward to saying it.—Ed.

● To my surprise you published a letter from me in the April issue of DESIGN ENGINEERING in which I said that if you forgot the west in your coverage, the west would probably decide to forget you! I am still waiting to see your interest showing.

In all other respects, congratulations. You are putting out a nice magazine. But remember we are part of Canada too.

T. D. VOGEL
Staff Designer
Vancouver.

Reader Vogel should look at DESIGN ENGINEERING'S pages 29, 82 and 88 (April) 21 (May) and the oilwell pump feature in this issue. Leads to any other western activities will be welcomed. Perhaps he has some suggestions?—Ed.

● We desire good things in design—but this letter is not about too much of a good thing; it is about too much of a mediocre thing. I am referring to National Industrial Design Council awards (DESIGN ENGINEERING, April). While two thirds of the awards go to products of superior appearance, one third go to items which are substandards or run-of-the-mill in their own lines.

The result is that the NIDC label has no meaning except that it looks pretty.

It should be an award for outstanding accomplishment in design and not for the mere fact that design occurred. If the standards were high, the receipt of the award would be a cause for pride. It would be a recognition worth striving for if effort beyond routine submission of the entry were required.

Perhaps to allow approbation of good but not exceptional work—especially in fields where competitive design is already excellent—the NIDC should have two colors of label. For example, because so many electric stove designs are fine it seems unlikely that much chance of earning a full award under discriminating

judgment exists; yet it is desirable to encourage maintenance of high standards.

Also, I feel that NIDC should go further than it does. It should offer forthright criticism, such as is offered in literary and theatrical fields. This service (if competently done) would benefit both designers and public.

MAURICE CONKLIN
Mechanical Engineer
Toronto.

● I have examined the prospectus for DESIGN ENGINEERING and believe that a magazine devoted to engineering design and development work in Canada, will meet a real need in industry. This type of magazine can acquaint the engineer with new Canadian engineering products and help to prevent duplicated research. I wish it every success.

J. C. FLOYD
Vice-President, Engineering,
Avro Aircraft Limited.
Toronto.

● Please advise us where we can get catalogue information on the testing equipment referred to in the article by M. J. Marko on page 36 of the April issue of DESIGN ENGINEERING.

C. W. JOHNSON,
Vice-President &
General Manager,
Canadian Sirocco
Co. Ltd.
Windsor.

Reader (and vice-president) Johnson has been put in touch with contributor (and vice-president) Marko.—Ed.

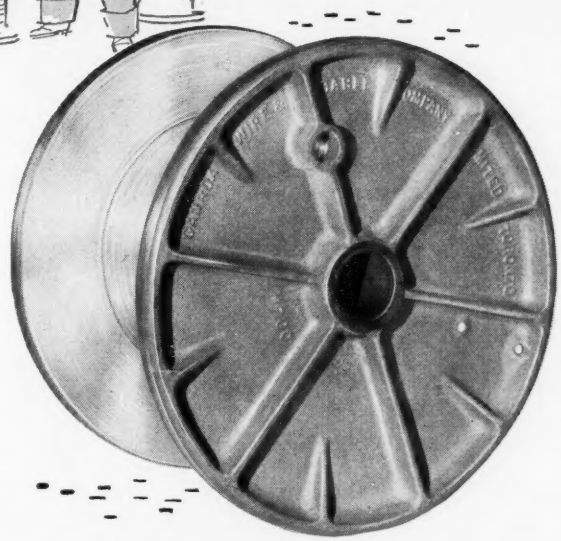
● I received my copy of DESIGN ENGINEERING and must say this magazine certainly came up to my expectations. The subject matter of your editorials and the general layout, I thought, was exceptionally good.

I was, however, slightly disappointed in the front cover — although possibly I have been spoiled by American publications . . .

But once you are beyond the front cover, you find yourself dealing with exactly the type of magazine that has been needed for some years by Canadian industry.

W. G. BURKE
Morrow Screw and Nut Co.
Ingersoll

Cut
shipping costs,
increase
plant efficiency



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320 BAY STREET • TORONTO, CANADA

Canadian Pump

(Continued from page 36)

a ball check valve at the base of a pump surge chamber in the head connections of the assembly.

Other features of the Green pump include:

1. Provision for advanced cut-off and valve gear head, resulting in protective end cushioning to eliminate head knocks. This is obtained by permitting piston rod linkage within No. 1 power cylinder only, immediately below the valve gear.

2. An automatic fluid-actuated engine throttle valve and governor, situated above the valve gear. This device has positive control over the pump, causes its complete shutdown if oil is not forthcoming from below.

3. A gas filter above the valve gear to remove any sediment which might be present in the incoming gas.

4. An extended 2-in. suction line from the pump to the bottom of the well, where a specially designed gas anchor is installed to prevent gas slippage up the oil tubing. The natural lift factor of gas pressure is utilized to drive the oil the short distance from the bottom of the hole to the pump.

Much interest is being shown in the Green pump. To one-time schoolteacher and gold prospector James Green (56) this is a hard earned success. He began work on the pump during a period of unemployment in 1936. For years he worked on the idea of a six-duct pump, then finally succeeded in designing the present four-duct system. In 1947 he built and tooled a machine shop to make the pump, had it 60% complete when an acetylene welder back-flashed, the shop caught fire and everything was burned. With the help of associate Jack Barnard he has built the pump again and hopes now to install one in a well soon. ★

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New Tester

(Continued from page 37)

change of capacity caused by the change of mass of the fibrous material within the condenser gap; compressing the strand between grooved rollers one of which is hinged, and measuring the displacement of the hinged roller; measuring the amount of light passing through a short portion of yarn; and there are a number of other methods. A recorder chart is obtained from which single numbers expressing "linear unevenness' can be computed.

In this textile application, the Sigma integrator has been built into a complete measuring unit called the Sigma Unevenness Tester. It is a capacitance-type unevenness tester and is the first instrument of its type to give the coefficient of variation on a specific sample automatically and by a correct statistical procedure. This is a considerable advantage for textile quality control and research. The Sigma Unevenness Tester was first shown in September 1954 at the Fourth Canadian Textile Seminar, a biennial conference of textile technical men. Since that time, a number of these testers have come into use in Canada. ★

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If you change your address be sure to notify our subscription department quoting both your old and new addresses.

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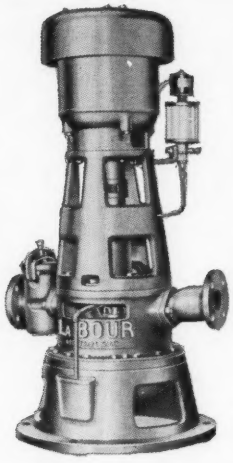
meets all control valve requirements

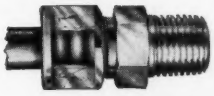
LaBOUR
self priming chemical pumps Standard and Packingless, designed for the Chemical and Process industries.



The DESIGN ENGINEER would do well to invite Kirk Equipment to provide detailed information on the various lines handled by them.

These include Dean-Hill Steam Turbines, Kraissl Strainers, Hoke Valves & Fittings, Warren Pumps, Panellit Control Panels & Panalarm Annunciator Systems.

Watch for additional depicted ads in this journal.



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"POP" Rivets handle blind spots and open sections—can be driven at rate of 1200 per hour.

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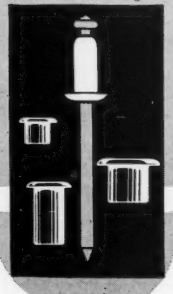

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Why not write and tell us about yourself, your experience, education, age, marital status—and your ambitions. Better still, if you happen to be in Toronto at any time, drop in and see us.

We shall, of course, respect your confidence.

B. A. Lawless, Personnel Manager,
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EMpire 3-5981, local 208

Flexible ACTION IN THE *New* HILLIARD TWIFLEX

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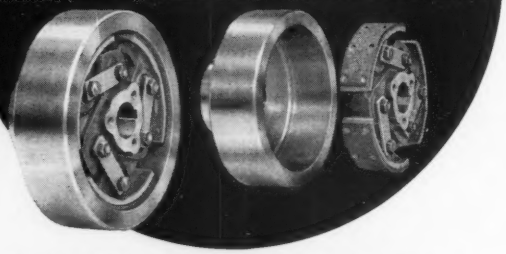

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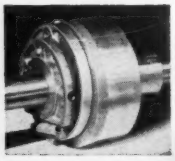
- Let Our Engineers Consider Your Problem. Twiflex May Be The Answer.



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For automatic engagement and release on two speed drives, dual drives and for ratchet feed or backstop action.

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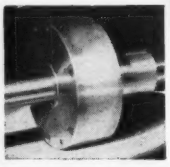

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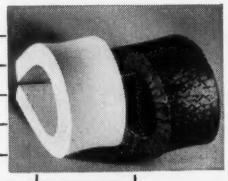

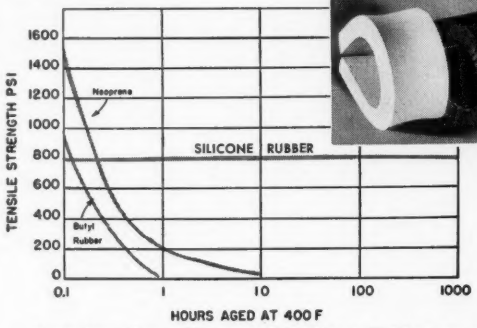

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GE SILICONE RUBBER

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

457W-455

Chemical Materials Department
Canadian General Electric Co. Ltd.
1601 Davenport Road, Toronto, Ont.

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*Company*_____

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Editorial

Graduation is Just the Start of the Road

HOW WELL EDUCATED are Canadian engineers? This is not an easy question to answer. Like plum pudding, education means so many things. There is undergraduate training, postgraduate training and then the harder, longer lessons of experience on the job — the training course an engineer can never complete.

But Col. L. F. Grant, president of the Engineers' Council for Professional Development accepted the question and gave a thoughtful answer: "So far as we can tell," he said, "undergraduate engineering education in Canada is good; it compares favorably with any other country. But in postgraduate training there are probably American and European universities with better facilities than ours."

This opinion is based on first-hand knowledge of Canadian and American engineering training. It is an important one. And it is less comforting than it may seem at one quick glance.

The new graduate engineer is at the starting post of learning. It is not good if his opportunities for postgraduate study are less than the best; and it is worse if industry feels it cannot give him the chance to experiment by developing Canadian projects with Canadian brains.

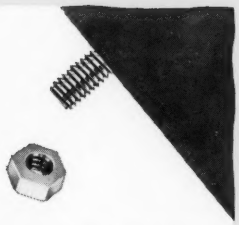
In the United States, business has learned the value of its engineers. A recent survey showed that all companies taking more than 25 young engineers a year onto their staffs, have strong postgraduate policies; they urge their technical men to study, make sure they have time to do so and later reward them with promotion; it can truly be said that all bigger American engineering companies believe that without continuing education there will be no continuing prosperity either for them or for their country.

The Canadian engineer is less fortunate. Dr. G. Edward Hall, president of the University of Western Ontario gave an idea of just how much less fortunate when he spoke last month to the Engineering Institute of Canada's annual meeting in Toronto.

After pointing out that business corporations are allowed to deduct up to 5% of their taxable income for donations to charities and education he went on to reveal that the average claimed in Canada is less than 1%. And this is shared by many charities. Only about 11% of the small total donation reaches our colleges and universities. Dr. Hall added punch to his point with some comparisons. One of them: In 1951, the universities had $741 for the education of each student. In the same year the jails had $1,670 for each convict!

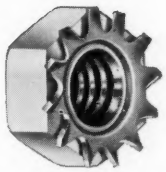
No wonder Canada's postgraduate facilities are less complete than could be wished. No wonder, too, that for the top jobs in Canada, Canadian industry looks so often to other lands for men; for it is all part of the same philosophy — a philosophy which was never good and becomes a costlier menace day by day as the country struggles toward big-scale production and independent thought. Government and management should look carefully at today's conditions with tomorrow's need in mind. Both will find there is much they should do — now.

Why KEPS save time...stay tight!

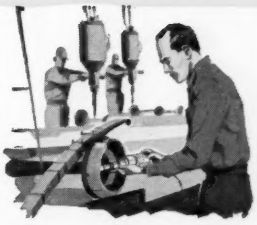


Loosening of ordinary nuts due to vibration is both dangerous and costly.

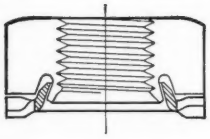
Lock washers are essential for most applications, but often hard to handle.



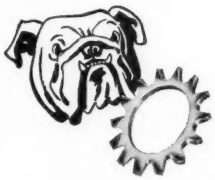
. . . except when nuts and lock washers are PRE-ASSEMBLED . . . as KEPS.



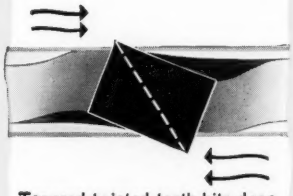
Then, awkward and costly separate lock washer handling is eliminated.



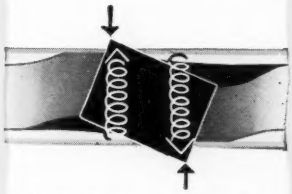
Nut and lock washer are mechanically pre-assembled as an integral unit.



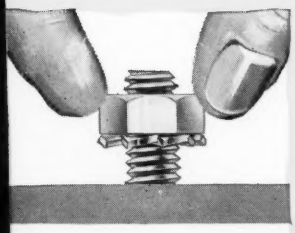
Shakeproof Lock Washers on KEPS lock tight because the teeth bite.



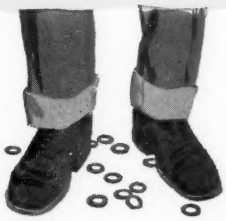
Tapered-twisted teeth bite deep to set up powerful resistance to any backward rotation.



Spring tension makes each tooth bite even deeper as vibration increases.

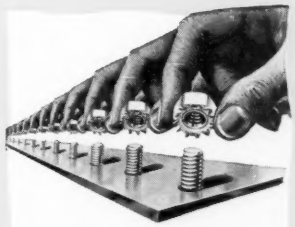


Starting KEPS is easier . . . Free running action makes driving faster, saves assembly time.



Washers can't drop off, can't be wasted or "forgotten."

Standards and specials meet a wide variety of requirements.



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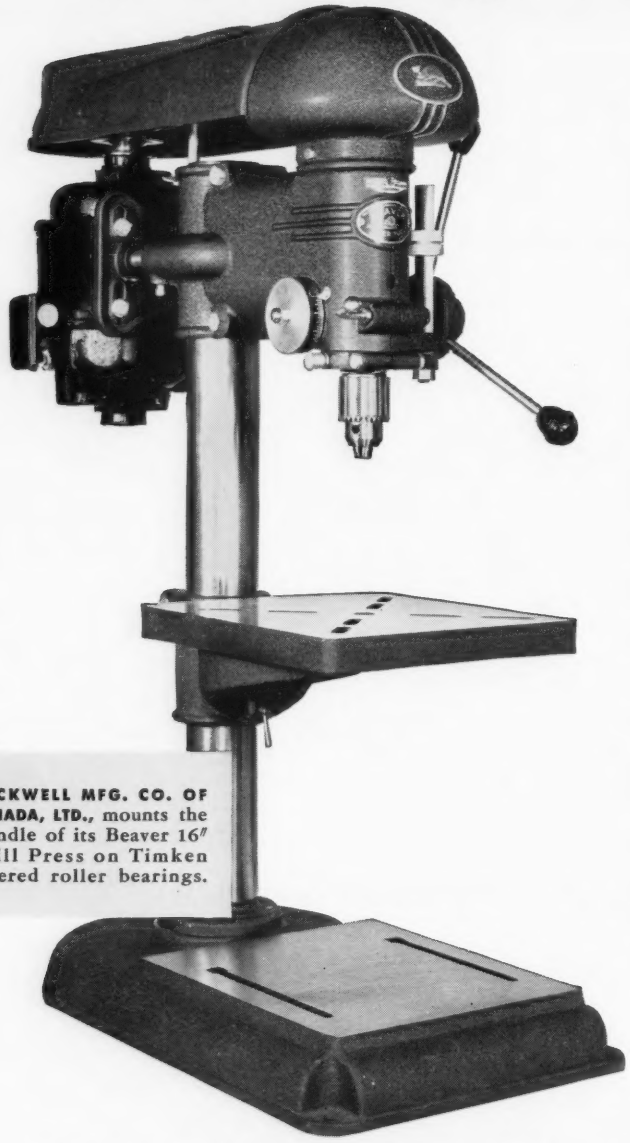

ROCKWELL MFG. CO. OF CANADA, LTD., mounts the spindle of its Beaver 16″ Drill Press on Timken tapered roller bearings.

THIS Beaver 16″ Drill Press is so accurate it is often used for precise pattern work, so rugged it is often used for high-speed production work like routing. All 6,000 of the presses built in the last seven years have had the spindle mounted on Timken tapered roller bearings. And there has never been a bearing failure.

The spindle is held in rigid alignment because the tapered construction of the Timken bearings lets them take both radial and thrust loads in any combination. Precision is increased, end play eliminated, gear wear greatly reduced. And there's less power loss in the drill press, because the smooth surface finish and true rolling motion of the Timken bearings practically eliminate friction.

Another reason for the high performance and longer life of the Timken bearings is that they're made of Timken fine alloy steel. We have to make our own steel to get steel good enough for Timken bearings. And we make it nickel-rich for added toughness.

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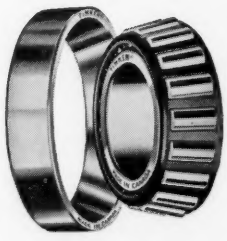
FOR CANADIAN INDUSTRY



NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⟨⟩ AND THRUST →⟨⟩← LOADS OR ANY COMBINATION →✳←